THE INFLUENCE OF SEASON, FLOW REGIME, AND WATERSHED LAND USE AND LAND COVER ON NUTRIENT DELIVERY TO TWO RAPIDLY URBANIZING WATERSHEDS IN CENTRAL INDIANA, USA

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ABSTRACT

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THE INFLUENCE OF SEASON, FLOW REGIME, AND WATERSHED LAND USE AND LAND COVER ON NUTRIENT DELIVERY TO TWO RAPIDLY URBANIZING WATERSHEDS IN CENTRAL INDIANA, USA

This study explores relationships between temperate stream geochemistry and watershed land use in order to understand the potential effects of changes in watershed land use. Geochemical properties, including NO_3-N, PO_4, DOC, SiO_2, Cl^-, and Na^+ were collected from two temperate streams, Fishback Creek and School Branch Creek, on the northwest side of Indianapolis in Eagle Creek Watershed, Indiana. The temporal and spatial patterns of collected parameters were assessed to understand the influence of land cover on the magnitude and timing of water, chemical, and nutrient delivery to streams. Both study watersheds are rapidly converting from agricultural to residential land use. Fishback Creek and School Branch Creek flow directly into Eagle Creek Reservoir, a source of drinking water for the City of Indianapolis. Increased nutrient input from the watersheds is believed to be a cause of increased algal blooms observed in the reservoir. The study utilizes a holistic approach to watershed research and management, combining in-stream water sampling, continuous monitoring, and remote sensing technologies. Easily analyzed and cost effective parameters including discharge, silica, sodium, and chloride proved to be adequate source water tracers. Silica concentrations identified sources of groundwater to the two temperate streams, while Na:Cl ratios proved effective in distinguishing agricultural from urban inputs. Results of the study indicate that the influences of different land cover types on water delivery to streams and in-stream water quality vary seasonally and with respect to in-stream flow conditions. Additionally, study results suggest that urbanization may result in decreased nitrate input. However, phosphate and dissolved organic carbon concentrations will likely remain constant as the watersheds are converted from agriculture to urban land use. Results also indicate that riparian buffer downstream of intense agriculture lands dilutes the high agricultural NO_3-N concentrations, but not enough to return in-stream concentrations to natural levels.

Lenore P. Tedesco, Ph.D.
(committee chair)

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INTRODUCTION

Excessive nutrient loading to streams, rivers, lakes and reservoirs is a global problem, leading to the eutrophication of many of the world's water bodies. The Gulf of Mexico in the U.S., European Coastal Waters, Canadian waters, and water bodies in nearly every developed or developing country has experienced some degree of eutrophication (Berner and Berner, 1987). In order to implement and monitor best management practices and other remediation efforts in these areas, the primary influences on nutrient delivery to streams and rivers must be identified.

This study seeks to understand the primary influences on source water and nutrients to streams in Eagle Creek Watershed. Eagle Creek Watershed is located in Indiana's White River Basin in the temperate, Mid-Western U.S. Waters from Eagle Creek Watershed feed into Eagle Creek Reservoir, a primary source of drinking water for the City of Indianapolis, Indiana. Over the past few years, the reservoir has experienced multiple algal blooms, resulting in taste and odor problems with the Indianapolis public water supply (Tedesco et al., 2003). The occurrence of algae blooms in Eagle Creek Reservoir coincides with the transition of Eagle Creek Watershed land use from agricultural lands to residential and light commercial development.

It is widely recognized that land use practices and associated alterations (such as deforestation and wetland drainage, or the removal of groundwater and runoff buffer zones, agriculture, dam building, changes in watershed relief, and increases in bare soil cover) greatly affect watershed stream loading of both dissolved and particulate constituents (Berner and Berner; 1987; Allan, 1995; Vanni et al., 2001; and McDowell et al., 2001). Increased nutrient loading can result in deterioration of water quality and increased nutrient input to down stream lakes and reservoirs, potentially stimulating eutrophic conditions resulting in algae blooms, as seen in Eagle Creek Reservoir (Allan, 1995).

Since 1980, there have been on-going efforts in Eagle Creek Watershed to identify and remediate extraneous sources of nutrients to the watershed's streams. In 1980, the Indiana Heartland Model Implementation Project determined that agricultural practices in watersheds can lead to degraded aquatic communities and that near-stream riparian buffer zones are vital to the maintenance of healthy aquatic communities (Gammon et al., 1982). Additionally, the project successfully implemented conservation tillage practices in the watershed to decrease agricultural related nutrient loading to streams (Hayes, 1981). From 1992 to 1996, the U.S. Geological Survey (USGS) completed a study on the White River Basin in Indiana as a part of the National Water Quality Assessment program. The study concluded that elevated nutrient levels are linked to land cover, determining that 61% of all nitrates in the study area are sourced from agricultural fertilizers, and that developed areas are major contributors to elevated in-stream phosphorus concentrations (Schnoebelen et al., 1999). In 2002, Veolia Water Indianapolis joined the Center of Earth and Environmental Science (CEES) at Indiana University-Purdue University Indianapolis to focus on studying and improving water quality in Central Indiana, forming the Central Indiana Water Resources Partnership (CIWRP). In 2004, the team completed a preliminary project in Eagle Creek Watershed investigating the relationship between land cover and nutrient loading. Results from the study indicated that land cover influences watershed nutrient loading, as nitrate and phosphate loads corresponded to the area of agriculture upstream of the sampling stations (Shrake et al., 2004). However, the study warranted a more detailed examination of these relationships. As a result, the CIWRP funded this study to further the work of the 2003-2004 study.

In fact, the relationship between agricultural land cover and nitrate and phosphate input to streams has been extensively investigated and there is thought to be a strong correlation between the two factors (Heisig, 2000; McDowell, 2001; Sharpley et al., 1995; Sharpley et al., 1999; Vanni et al., 2001; and Gburek and Sharpley, 1998). However, few studies have employed detailed field sampling techniques to examine the effects of mixed and developed land cover on nutrient loading (Coulter et al., 2004; McMahon and Cuffney, 2000; and Frick and Buell, 1999). In 2004, Coulter et al. (2004) examined three watersheds simultaneously to determine if there is any correlation between watershed land use and in-stream nutrient concentrations and fluxes. Coulter et al. (2004) studied one watershed dominated by agriculture, another urban, and a mixed watershed, and found that the agricultural watershed had significantly higher in-stream nitrate and phosphate concentrations, but that fluxes of nitrate, ammonium, and total phosphorus did not vary among the three watersheds. Other studies have been limited to modeling the effects of land use on in-stream water quality with geographical information systems (Greene and Cruise, 1995; Nikolaidis et al., 1998; Cassell et al., 2001; and Ackerman and Schiff, 2003). While these studies yield robust results, many of them require extensive temporal and spatial data sets that simply are not available for smaller watersheds in rural regions.

Land use can greatly affect an area's drainage by altering natural drainage patterns. It is widely accepted that impervious surfaces, storm sewers, and drainage ditches associated with development result in the rapid delivery of storm runoff to nearby streams. Agricultural tile drainage also affects the timing and delivery of water and nutrients to nearby streams. Tile drainage not only increases the magnitude of water discharged to the stream, but it also increases the magnitude and delivery rate of nitrate from agricultural fields to streams (Kladivko et al., 1999). Currently, the USGS is completing a study as a part of the USGS National Water Quality Assessment (NWQA) Program in the Leary Weber Ditch Watershed in Mohawk, Indiana to assess agricultural chemical fate and transport. The agricultural practices in the watershed consist of corn and soybean row cropping, typical in the Midwest. Preliminary results indicate that in highly agricultural Midwestern watersheds nitrate concentrations in tile drains and tile drain-fed streams are similar and range from 0 to 20 mg N/L, whereas nitrate in near-surface groundwater in agricultural areas is much lower and rarely surpasses 10 mg N/L (USGS, 2005).

Other studies employ the use of silica (SiO_2) concentrations and Na:Cl ratios to trace the source and path by which waters enter the stream. Although SiO_2 concentrations vary regionally, they can be used to discern that waters have passed through the subsurface from runoff. It is assumed that precipitation sourced runoff waters have SiO_2 concentrations similar to precipitation with little to no SiO_2, whereas waters that infiltrate the ground have higher silica concentrations due to rapid silica equilibrium reactions in groundwater (Buttle and Peters, 1997; Kennedy, 1971; and Kennedy et al., 1986). Groundwater assessments completed in Central Indiana indicate that typical groundwater SiO_2 concentrations average 9.1 mg SiO_2/L, while incident precipitation has an average SiO_2 of 0.0 mg SiO_2/L (Smith et al., unpublished data). Na:Cl ratios, although not widely used, can also be used as an indicator of source waters as urban related runoff typically has an Na:Cl ratio of 1.00 due to the use of water softener and road salts. Chloride is typically found in fertilizers but there is no significant natural or anthropogenic source of sodium in regional agricultural lands, hence agricultural drainage can be assumed to have Na:Cl ratios less than 1.00.

Streams are also extremely dynamic systems that are influenced by a host of environmental factors in addition to surrounding land cover. For example, climate affects precipitation fluctuations and soil moisture, while surrounding topography and geology play a role in stream flow and geochemistry. Overall, there is a lack of understanding of how factors such as flow regime, season, and land use and land cover characteristics, such as riparian buffer, slope, and soils, simultaneously influence the delivery of nutrients to streams. These types of studies are imperative to understand the timing, delivery, and magnitude of nutrients to streams, and are critical factors when implementing and monitoring watershed best management practices and remediation.

In order to prevent future algae blooms in Eagle Creek Reservoir and to maintain stream health, it is important to understand the primary influences on source water and nutrients to streams in Eagle Creek Watershed. The purpose of this research is to determine if watershed characteristics, such as slope, riparian buffer, and land use influence the delivery and magnitude of water and nutrients to streams. The study employs a holistic approach, utilizing remote sensing technologies, source water identification, and stream geochemistry to understand the influences of season, flow regime, and watershed land use and land cover characteristics on source water and nutrient concentrations to small Midwestern streams in Eagle Creek Watershed, Fishback Creek and School Branch.

STUDY SITE

Setting

Fishback Creek and School Branch Watersheds lie within Eagle Creek Watershed in Central Indiana (Figure 1). Eagle Creek Watershed has a drainage area of approximately 419.6 km^2 (162 mi^2) above the Eagle Creek dam. Approximately 60% of Eagle Creek Watershed is covered by agricultural lands, while 10% is developed. The vast majority of the remaining 30% is either forested or is herbaceous grassland. Waters from Eagle Creek Watershed feed into Eagle Creek Reservoir, which was constructed in 1967 by damming Eagle Creek just north of present day Interstate 70, approximately 10 miles northwest of Indianapolis (Tedesco et al., 2003).

The USGS defines drainage basins as regions bounded by drainage divides that gather water originating as precipitation and contribute it to a particular stream channel or other waterbody. These areas of land are then organized by size and given a hydrologic unit code (HUC). HUC 11 watersheds range in size from 40,000 to 250,000 acres, while HUC 14 sub-watersheds generally range in size from 10,000 to 40,000 acres (USGS, 1999). Eagle Creek Watershed, a USGS HUC 11 watershed, has ten HUC 14 sub-watersheds nested within its boundaries (Figure 1). Fishback Creek and School Branch Watersheds, two of the ten HUC 14 sub-watersheds in Eagle Creek Watershed, are the focus of this study.

Fishback Creek and School Branch Watersheds were selected for several reasons; both are isolated watersheds that feed directly into Eagle Creek reservoir and both contain a variety of land cover types. Additionally, both watersheds are undergoing rapid urbanization, but have distinct land cover boundaries along stream reaches (Figure 1). The two watersheds are in portions of Boone, Hendricks, and Marion counties just northwest of Indianapolis, Indiana, USA (Figure 1). Fishback Creek is a second order intermittent stream, while School Branch Creek is an intermittent first order stream. Fishback Creek and School Branch have stream lengths of 25 km (15.5 mi) and 15 km (9.3 mi) and drainage areas of 58 km^2 (22.4 mi^2) and 25 km^2 (9.7 mi^2), respectively.

Climate

Indiana is located in the mid-western portion of the United States. The temperate climate is characterized by monthly mean temperatures ranging from 3.9 to 23.3 °C (25 to 74 °F), while in-stream water temperatures range from 1 °C (33 °F) in winter months to 24 °C (80 °F) in the summer. Average rainfall in the region is 124.5 cm (49 in), and average precipitation associated runoff in Eagle Creek Watershed ranges from 25.4 cm (10 in) to 30.5 cm (12 in) annually (Clark, 1980). More than half (54%) of the average annual precipitation typically occurs during the spring and summer months (March through August). As a result, the timing and magnitude of groundwater recharge and surface runoff are affected by the distribution of precipitation (Clark, 1980). In Indiana, approximately 68% of the precipitation is lost as evaporation, 9% recharges groundwater reserves, and the remaining 23% becomes surface runoff (Clark, 1980).

During the study period (April 2004 through April 2005), a total of 109.94 cm of precipitation occurred in the study area. Monthly precipitation ranged from 0.99 to 16.82 cm. The largest percentages of rain occurred during May (12.98%), July (11.68%), and

November of 2004 (10.97%), January of 2005 (16.82%), and April of 2005 (10.22%) (Table 1).

Although monthly precipitation during the study did not follow typical seasonal trends, the study area does experience distinct dry and wet seasons with respect to discharge. During the summer and fall seasons, groundwater is depleted and soil moisture conditions are low, thus precipitation yields lower in-stream discharges. Figure 2, a plot of cumulative discharge versus cumulative rainfall during the study period, illustrates this trend and clearly shows that the dry season for the study year was from approximately June 28, 2004 to December 6, 2004. A six-year study at the Purdue University Water Quality Field Station in Tippecanoe County, Indiana found that groundwater discharge from agricultural tile drains decreases dramatically between June and July and is not measurable from August through November. Groundwater flushing via agricultural tile drainage networks increases dramatically from February to March and peaks in May (Brouder et al., 2005).

Geology

Eagle Creek Watershed lies entirely within the Tipton Till Plain (Wayne, 1966). Resulting from extensive quaternary glaciation (Wayne, 1966), Tipton till deposits are loam till and form the rich soil complexes throughout much of Central Indiana. These deposits range from 50 feet to 350 feet and average approximately 200 feet in thickness (USGS, 2004). The soils within Eagle Creek Watershed are developed in glacial materials and are generally poorly drained (Clark, 1980; Hall, 1999). The soil associations in Eagle Creek Watershed include Crosby-Treaty-Miami in the nearly level to gently sloping headwater regions, and the Miami-Crosby-Treaty association along the level to moderately steep downstream areas. The Crosby-Treaty-Miami association consists of a deep, poorly drained soil, while the Miami-Crosby-Treaty association is a deep well drained to somewhat poorly drained soil.

The majority of Fishback Creek and School Branch watersheds are comprised of typical Tipton Till Plain soils. However, large areas of outwash of the Atherton Formation can be found along Fishback Creek in Boone County and in and around Eagle Creek Reservoir. Additionally, lake silt and clay deposits are present in the headwaters of Fishback Creek, and modern alluvium deposits can be found along most of the streams throughout the watershed (Wayne, 1966).

Watershed Characteristics

The rich soils and relatively flat topography of the Tipton Till Plain are among the reasons for Eagle Creek Watershed's intensive agricultural history. Currently, Fishback Creek and School Branch watersheds are predominantly agricultural land cover, with approximately 60% and 65% of the watersheds dedicated to agricultural practices, respectively (Figure 1). While there are several small, private livestock farms along the stream reaches, most agricultural land in both watersheds is dedicated to corn and soybean production. Due to the low permeability of the watershed soils, the vast majority of agricultural lands have extensive tile drainage systems. These systems move water quickly off of the landscape to nearby drainage ditches and streams. Conservation tillage practices have been implemented to some degree in Boone and Hendricks counties to combat nutrient loading to streams. According to the Indiana Department of Natural

Resources (IDNR), in 2004 Hendricks County had higher percentages of corn and soy cropland in conservation programs than many other Indiana counties. Hendricks County ranked 31 for corn and 16 for soy out of the 90 counties for percent no-till, while Boone ranked 74 and 37 (90 of 92 Indiana counties participated in the study) (Table 2) (IDNR, 2004).

However, Fishback Creek and School Branch watersheds are undergoing rapid land cover changes; agricultural land is being converted to residential and commercial land use to accommodate the growing Indianapolis population. Of the ten sub-watersheds in Eagle Creek Watershed, School Branch experienced the third highest increase in urban development between 1985 and 2003 with an increase of 10.44%, while Fishback Creek ranks fifth with an increase of 8.23%. Nearly all of the detected development in the watersheds is occurring closest to Eagle Creek Reservoir (Figure 1). Recently, the Land Use in Central Indiana (LUCI) Model was applied to the Eagle Creek Watershed (Tedesco et al., 2003). Results of the model indicate that School Branch and Fishback Creek will be 65% and 59% urban by 2040. Of the ten sub-watersheds in Eagle Creek Watershed, School Branch and Fishback Creek Watersheds rank 3rd and 6th, respectively, for the largest predicted percent urban land cover. It is predicted that School Branch will see a 47% increase in urban area and Fishback Creek a 49% increase from 2000 numbers.

METHODS

This study employs a holistic approach to understand the influences of seasonality, flow regime, and land cover on the sources and magnitude of water and nutrients to small temperate streams. A combination of remote sensing technologies and water quality were utilized. Water quality was continuously monitored using permanently deployed water quality probes and grab samples were also collected seasonally. Remote sensing and field observations were used to determine the ideal location of stream sampling stations and characterize the land cover and landscape between each of the stations. Continuous monitoring stations were used to capture event hydrographs associated with each sampling and to understand the response time of the streams to large amounts of precipitation. Finally, in-stream sampling of silica (SiO_2), sodium (Na^+), and chloride (Cl^-) were used as source water tracers, while nitrate (NO_3-N), phosphate (PO_4), and dissolved organic carbon (DOC) were used as water quality indicators.

Land Cover and Landscape Characterization

Before characterizing the watershed, it was necessary to redefine the boundary of School Branch watershed to only include the drainage area feeding the stream. The USGS School Branch HUC 14 watershed boundary includes Eagle Creek Reservoir and the associated shore drainage area. However, for the purposes of this study an accurate assessment of the drainage area only to School Branch was necessary. ArcGIS hydrotools and digital elevation model (DEM) data were used to generate the boundaries of both School Branch and Fishback Creek used in the study. A minimum cell threshold of 4,000 cells produced the most representative watersheds for both Fishback Creek and School Branch, based on interpretation of slope and flow accumulation layers.

Sampling station locations were selected in order to capture in-stream nutrient variation among a single land cover type. NRCS 2003, 1.0 m^2 imagery was examined to assess ideal locations for stream sampling stations and permanent monitoring locations. Stations are located upstream and downstream from different land cover regions in the watershed, at the base of the watershed near the stream discharge point to Eagle Creek Reservoir, and where there is access to the stream. To capture variation among a single land use, sampling stations were added in some land cover regions of the watersheds. Seven sampling stations are located along School Branch and eight along Fishback Creek (Figure 3). Permanent monitoring stations are located at agricultural/development land cover boundaries and closest to Eagle Creek Reservoir. In School Branch watershed, permanent monitoring stations are located at SB 3 and SB 1, while in Fishback Creek at FC 4 and FC 1.

Once sampling stations were established, the catchment area between each station was delineated and characterized. It was necessary to quantify the land cover characteristics and land use in the catchment area between each designated station in order to determine if these characteristics are related to water and nutrient inputs to the streams. Watershed areas between each of the study sample stations (Figure 3) were visually delineated using the known sampling locations and a digital slope surface cost analysis layer, generated in ArcMAP using a DEM data set.

Land cover and slope data for the area between each station was generated by creating an area of interest layer (AOI) from each of the watershed and between station area shapefiles. DEM, 2002-2003 land cover, and slope data sets were queried using the between station area AOI layers, and a subset of each of the data sets was generated. The attributes associated with each of the subset images were queried and areas associated with specific land cover classes were compiled for the area between each of the stations.

Buffer area along Fishback Creek and School Branch was quantified using both remote sensing techniques and field observations around each sampling station. 2003 NRCS 1 m^2 aerial photography was systematically viewed and stream reaches with both adequate and inadequate riparian buffer were measured. For the purposes of this study, a width of 25 feet was used to measure adequate riparian buffer (although at times more than 25 feet of buffer should be present), and a visual survey of buffer area around each station was completed in 2005 to confirm remote results.

Adequate buffer width was determined based on the United States Department of Agriculture and the Natural Resources Conservation Service riparian forest buffer conservation practice standards. For the purposes of this study, only woody riparian buffer was assessed. Grassy buffer strips were not included in buffer measurements. The USDA and NRCS requires a minimum woody riparian buffer width of 35 feet or 30 percent of the geomorphic flood plain, whichever is less, to reduce excess amounts of sediment, organic material, nutrients, pesticides, and other nutrients and chemicals in shallow groundwater flow (NRCS, 2004). The width was reduced to 25 feet in this study due to the extremely small floodplain widths along Fishback Creek and School Branch. In addition, this study is primarily concerned with the ability of riparian buffers to remove nitrate from shallow groundwater and several studies indicate that this process primarily occurs in the first 10 to 15 meters of forest (Lowrance et al., 1984; Peterjohn and Correll, 1984; and Jacobs and Gilliam, 1985).

Watershed Continuous Monitoring

Multi-parameter water probes, deployed at Stations SB 1, SB 3, FC 1, and FC 4, collected water level, temperature, and specific conductance data every fifteen minutes for the entire hydrologic year. The probes located at Stations SB 1 and FC 1 also collected pH and dissolved oxygen. Deployed monitoring probes were calibrated in the field every 30 to 60 days to ensure instrument accuracy. The continuous monitoring data were necessary to assess stream conditions during a sampling event, understand the evolution of large flow events, and for the collection of stream hydrograph data and associated in-stream chemical parameters for sampling dates.

Field Sampling

Field sampling was completed during both the dry and wet season at base and event flow conditions. Event flow conditions were defined as stream discharge at least two times greater than seasonal base discharge, where base discharge is defined as the 40 year mean monthly discharge. The monthly mean measurement was taken from the USGS gauging station in Eagle Creek at Zionsville, Indiana (Figure 1). Continuous monitoring data were used to confirm base versus event flow conditions. Table 3 lists the date, season, and flow conditions of sampling in each watershed. Stations were sampled from the headwaters toward Eagle Creek Reservoir on each stream. Discharge was measured in-situ at each station using an acoustic dopler velocity meter, with the exception of the June 2004 event flow samplings when stream conditions were too high to safely enter the stream. In these cases, discharges were estimated using a modified SCS curve number method (Stevens, 2005). General in-stream water parameters, salinity, pH, temperature, dissolved oxygen, specific conductance, and total dissolved solids, were collected at each sampling location with a calibrated YSI™ 600 XLM multi-parameter water quality probe. A three gallon grab sample was collected from the middle of the stream at mid-depth at each station and split in the field for chemical analysis. One liter of sample was allocated for nitrate, dissolved organic carbon, and major ion chemistry and 150 ml for phosphate analysis. Samples were collected in acid cleaned Nalgene™ polyethylene containers. Duplicate samples were also collected at one station every sampling event, and field blanks were collected for analysis twice throughout the course of the study. Water samples were stored in a cooler for field transport on ice and refrigerated at 4º C in the laboratory prior to analysis.

Chemical Analysis

Collected water samples were analyzed for dissolved silica, chloride, sodium, nitrate, and dissolved organic carbon by Veolia Water Indianapolis, LLC (an EPA certified laboratory), while phosphate analysis was completed using facilities at Indiana University-Purdue University, Indianapolis. Table 4 lists the method description, EPA standard method designation, detection limit, and percent error for all parameters analyzed in the study. Samples transported to Veolia laboratories were immediately pre-filtered if necessary and analyzed within 24 hours of collection. NO_3-N, Na^+, and Cl^-

were analyzed on a Dionex™ Ion Chromatograph. DOC was measured on a Tekmar™ Phoenix 8000, using the UV persulfate method of TOC analysis, while SiO_2 was measured colorimetrically after acidification and reaction with molybdate on a Bausch and Lomb Spectronic 88.

At IUPUI facilities, two 12 ml aliquots of phosphate sample were immediately filtered through a 0.45 um filter into 15 ml tubes, and frozen until analyzed. Phosphate was determined by the Ascorbic Acid Method, SM 4500-P E, using either a Shimadzu™ UV-2401PC Spectrophotometer system or a Thermo Electron Konelab™ (Clesceri et al., 1998). Veolia Water Indianapolis, LLC and IUPUI laboratories both employ stringent quality control practices, including 5 point calibration curves, use of a certified EPA standard, and a lab check standard. Additionally, analysis of field blanks insured sample purity.

Data Analysis

Datasets were assessed based on seasonality and were grouped by wet and dry seasons. Wet and dry seasons were determined using Figure 2, a plot of cumulative discharge versus cumulative rainfall during the study period. The slope of the line approaches zero from approximately June 28, 2004 to December 6, 2004, indicating that the majority of precipitation recharges groundwater or is evaporated and little is discharged to nearby streams. As such, the period from June 28, 2004 to December 6, 2004 is referred to as the dry period.

Source water inputs to the stream were assessed using downstream trends in discharge and the percent of total water contribution to the stream by the area between each axial station. Dissolved SiO_2 was used as a groundwater tracer to identify reaches of the stream influenced predominantly by groundwater flow as opposed to those influenced by low dissolved SiO_2 waters such as surface runoff. Additionally, agricultural drainage versus urban drainage were identified using a combination of Na:Cl ratios and Cl^- concentrations.

Downstream variation in mean instantaneous percent water contribution and depth of runoff were compared to changes in land use and land cover characteristics. Instantaneous percent water contribution was calculated as the percent of total discharge contributed to the stream between each station. Depth of runoff was calculated as the change in discharge between each station normalized by the between station area.

In-stream nutrient concentrations were compared to land use and land cover characteristics and were used to determine the relationships between land use and land cover characteristics and in-stream nutrient concentrations.

RESULTS

Results from the land cover and landscape characterization are presented in Tables 5 and 6 and Figures 4 and 5. Discharge, between station loading, and depth of runoff were analyzed spatially to understand relative inputs from drainage areas between each station and are reported in Tables 7, 8, and 9. In order to accurately assess the variability of water and nutrient to the streams, downstream concentrations of SiO_2, Cl^-, NO_3-N, PO_4, and DOC and Na:Cl ratios were analyzed spatially relative to base and event flow regimes, season, and soil moisture conditions. Results are summarized in Table 7 and Figures 7 and 8.

Land Cover and Landscape Characterization

Watershed Boundaries

Re-delineation of Fishback Creek and School Branch Watershed boundaries, resulted in areas of 58.77 km^2 (22.4 mi^2) and 25.03 km^2 (9.7 mi^2) (Table 5), respectively. As a result, Fishback Creek gained approximately 4.5 km^2 (1.7 mi^2) of drainage area, while the drainage area of School Branch Watershed was reduced by over half from 51.0 km^2 (19.7 mi^2) relative to the USGS HUC 14 watershed areas. The USGS HUC 14 delineation of School Branch Watershed included the catchment area associated with Eagle Creek Reservoir. The new delineation eliminated the extraneous catchment area associated with Eagle Creek Reservoir and represents only the area draining directly to School Branch.

In the ArcGIS hydro-modeling tools package, a delineation threshold of 4,000 cells produced the most representative watersheds for both Fishback Creek and School Branch, based on interpretation of slope and flow accumulation layers. Figure 4 illustrates the difference between the USGS watershed delineation and that done with use of ArcGIS.

Between station areas range from 0.48 km^2 (0.19 mi^2) to 13.29 km^2 (5.13 mi^2) (Table 5). The smallest between station area is located nearest the reservoir in Fishback Creek (FC 1 to FC 2), while the largest is in the headwaters of Fishback Creek (FC 8 to headwaters) (Figure 3 and Table 5).

Land Cover

Analysis of 2002-2003 land cover data show that agriculture, herbaceous grassland, forest, and development comprise the majority of both Fishback Creek and School Branch Watersheds, with mines, quarries, and excavations and open water being minor features of the watersheds' landscapes (Table 5). The headwater regions of both watersheds are primarily agriculture. Downstream there is a shift to increasing amounts and percentages of forest, herbaceous grassland, and development (Table 5). Overall, School Branch Watershed has a higher percentage of agricultural land use (65.3%) than Fishback Creek (59.6%). The highest percentages of agriculture are found upstream of stations FC 6 and SB 4. With 15.22% of the watershed categorized as forested land cover, Fishback Creek has 9% more forested land cover than School Branch Creek (Table 6). Both Fishback Creek and School Branch Creek have similar percentages of total development with 9.42% and 10.5%, respectively, with development occurring closest to

Eagle Creek Reservoir. Between stations FC 2 to FC 6 and SB 1 to SB 3 over 13% of the watershed areas are either high or low density development. Low density development is the dominant type of development in both watersheds. No high density development was detected in School Branch Watershed in the analysis of the 2003 imagery.

Figure 5 illustrates the downstream trends of the relative percentages of agriculture, forest, and development upstream of each station. In Fishback Creek Watershed the relative amount of agricultural land use influencing the water chemistry at each station decreases downstream. However, in School Branch Watershed the relative amount of agriculture upstream of each station increases to a maximum at Station SB 4 and then decreases toward Eagle Creek Reservoir. Likewise, in both watersheds, as the relative amount of agriculture upstream of each station decreases an increase in the relative percentages of forest and development are observed.

Buffer Area

Woody riparian buffer areas are present along both Fishback Creek and School Branch. In both watersheds, there is virtually no woody riparian buffer in the headwaters/agricultural regions of the watersheds, while increases are observed downstream in both watersheds to Eagle Creek Reservoir. Fishback Creek has considerably more buffered stream reach than School Branch (Table 6). As of 2003, 56.72% of Fishback Creek and 33.54% of School Branch stream reaches have adequate buffer (a minimum of 25 feet on each side of the stream). 100% of the stream reaches from Station FC 2 and SB 1 to ECR and from Station FC 7 to FC 6 have adequate buffer. The rest of the stream reaches lack varying percentages of adequate buffer (Table 6). In general, with the exception of the area between Stations FC 7 to FC 6, the percent of stream reach with adequate buffer increases from the headwaters of both watersheds toward Eagle Creek Reservoir. Additionally, no adequate buffer was identified between stations SB 6 to SB 5 or upstream of both SB 7 and FC 8 (Table 6).

Slope and Elevation

Percent slope, elevation, and valley incision increase from the headwaters toward Eagle Creek Reservoir in both School Branch and Fishback Creek. Fishback Creek has much higher percentage slope values and more variability than School Branch watershed. In Fishback Creek Watershed, percent slope values range from 0.5 to 4.1%, while in School Branch Creek Watershed, percent slope values range from 0.3 to 1.5%. The mean slope in Fishback Creek is 1.3%, while in School Branch the mean slope is 0.9% (Table 6). The largest slopes of any of the between station areas are found in Fishback Creek Watershed closest to the Eagle Creek Reservoir, between stations FC 3 and FC1, with FC 1 having the largest mean percent slope at 4.1% and the largest maximum percent slope of 23.8% (Table 6). Elevations in the two watersheds range from 241.0 m (790.48 ft) to 299.0 m (980.72 ft) above sea level. The highest elevations in the study area are located in Fishback Creek Watershed nearest Eagle Creek Reservoir.

Hydrology

Discharge was highest during wet season event flow conditions and lowest during dry season base flow. During the wet season (mid-December to late June) the mean sampled discharge for event flow conditions was 3.22 m^3/s, while measured discharges ranged from 0.37 to 9.59 m^3/s; the dry season (late-June to mid-December) event flow discharge mean was 0.13 m^3/s and ranged from 0.00 to 0.41 m^3/s (Table 7). However, during the dry season at both event and base flow conditions many stations were ponded or dry. No measurable discharge was observed upstream of SB 3 and FC 2 in September, upstream of Stations SB 3 and FC 5 in October, and at Stations SB 7 and FC 8 on the November sampling date. The observed precipitation pattern does vary from what the region typically experiences. Annual rainfall during the study was approximately 20 cm less than average. Additionally, the percentage of rainfall that occurred during the spring months was nearly 10% less than a typical year.

Discharge typically increased downstream (Figure 6). However, some downstream decreases in discharge were observed at isolated stations during dry season event flow conditions and during base flow conditions year round and may be a result of instrument inaccuracy at low velocities. During the wet season, discharge increased between stations an average of 0.22 m^3/s per kilometer of stream length, whereas during the dry season it increased an average of 0.04 m^3/s per kilometer of stream length.

Mean instantaneous percent water contribution calculations for dry and wet season event and base flow are reported in Table 8, and values range from -66.48% to 108.82%. Downstream instantaneous percent water contribution of between station areas varies significantly with respect to season and flow regime. During dry season base and event flow samplings, percent water contribution increases downstream in both watersheds (Table 8). During wet event conditions, percent water contribution typically decreases downstream in both School Branch Watershed, from 23.69% to 8.10% at Station SB 3, and Fishback Creek Watershed, from 20.00% to 1.10% nearest Eagle Creek

Reservoir. On School Brach, an increase occurs between Stations SB 3 and SB 1, where percent water contribution jumps from 8.10% at SB 3to 31.86% at SB 1. During wet base conditions, percent contribution varies significantly among between station drainage areas, and negative values were observed at three stations in Fishback Creek.

Depths of runoff from between station areas are lowest during the dry season at base flow, and highest during wet season event flow conditions (Table 9). During the dry season depth of runoff is highest toward Eagle Creek Reservoir. In Fishback Creek, the highest runoff values are also observed nearest Eagle Creek Reservoir during the wet season at both event and base flow, nearly tripling in some instances. However, in School Branch Watershed headwater and middle regions generate the highest depth of runoff during wet season event flow conditions.

Ion Concentrations

Silica

Silica concentrations were highest during the dry season at both base and event flow conditions. Mean SiO_2 concentrations for dry season base and event samplings were 9.17 mg SiO_2/L and 8.68 mg SiO_2/L, respectively. During the dry season at base flow conditions no downstream silica trend is observed, rather concentrations are highly variable downstream. During event flow conditions, downstream silica concentrations along School Branch increase until Station SB 3 and then decrease downstream toward Eagle Creek Reservoir. Along Fishback Creek, SiO_2 concentrations are generally higher in the headwaters than nearest Eagle Creek Reservoir (Figure 7).

Mean concentrations for the wet season base and event flow were 5.43 mg SiO_2/L and 8.63 mg SiO_2/L, respectively (Table 7). During the wet season, SiO_2 concentrations generally decrease downstream along both streams at both event and base flow conditions. Overall, SiO_2 concentrations were higher in 2004 than those observed during 2005 (Figure 7).

Chloride

During the dry season, chloride concentrations were generally higher than during the wet season. The highest mean concentration and range were observed during the dry season base flow sampling, with a mean of 52.86 mg/L and a range of 23.36 to 158.68 mg/L. The lowest mean chloride concentration occurred during the wet season at event flow conditions with a mean and range of 21.98 mg/L and 14.13 to 48.57 mg/L, respectively (Table 7). Headwater concentrations of chloride are similar in both watersheds, and vary only with respect to season.

Chloride concentrations typically decrease downstream on School Branch during the wet season and increase downstream on Fishback Creek. Increases on Fishback Creek begin around Station 5 and continue to Eagle Creek Reservoir. During the dry season, observed downstream trends are similar to the wet season on Fishback Creek when stations are flowing, while on School Branch chloride concentrations increase downstream. However, chloride concentrations are highly erratic among ponded stations (Figure 7). As previously discussed, stations upstream of SB 3 and FC 2 in September, upstream of Stations SB 3 and FC 5 in October, and at Stations SB 7 and FC 8 on the November sampling date had no measurable discharge.

Na:Cl Ratios

Na:Cl ratios are lowest during the wet season. Mean and ranges of wet season base and event flow concentrations are similar. During base flow, the mean and range of Na:Cl ratios is 0.45 and 0.32 to 0.58, while during event conditions they are 0.43 and 0.28 to 0.63 (Table 7). Additionally, downstream Na:Cl trends are similar to chloride trends during the wet season, although the magnitudes of the observed increases and decreases among Na:Cl and Chloride vary along Fishback Creek. Both watersheds have similar concentrations in the headwaters. Then, concentrations increase toward Eagle Creek Reservoir on Fishback Creek, and decrease toward Eagle Creek Reservoir on School Branch. Dry season Na:Cl ratios are higher than observed in the wet season. Additionally, during the dry season Na:Cl ratios are variable in the headwaters of both streams, while downstream Na:Cl ratios become similar in both watersheds and range from approximately 0.60 to 1.00 (Figure 7).

Water Quality Indicators

Nitrate

The highest mean and range in NO_3-N concentrations was observed during the wet season during event flow conditions, while the lowest concentrations were recorded during the dry season (Table 7). Wet season event mean and range values were 9.85 mg N/L and 2.11 to 19.40 mg N/L, respectively. However, downstream wet season event concentrations diverge. During the wet season, concentrations are similar in the headwater regions of both watersheds. On Fishback Creek, concentrations typically decrease from the headwaters to Eagle Creek Reservoir. However, during 2004 a large increase in nitrate concentration is observed between Stations 7 and 6 along School Branch, and then a slight decrease is observed toward Eagle Creek Reservoir. Concentrations on School Branch are nearly four times those on Fishback Creek closest to Eagle Creek Reservoir. During wet season base flow conditions, downstream trends are similar in both watersheds and are similar to those observed during wet season event conditions. However, during the wet season baseflow sampling, there is less downstream divergence of concentration among the watersheds (Figure 8). During the dry season, the majority of nitrate concentrations were below detection limit (0.10 mg N/L).

Phosphate

Phosphate concentrations are highest during the dry season at base flow conditions, with a mean and range of 0.25 mg/L and 0.10 to 0.77 mg/L (Table 7). The lowest phosphate concentrations were recorded during wet season base flow conditions (Table 7). During the dry season, some of the highest phosphate concentrations are observed at ponded stations. Near Eagle Creek Reservoir, concentrations in both watersheds are similar (~0.005 mg/L) during the dry season and lower than observed at headwater stations (Figure 8). In 2004, during wet season event flow conditions, concentrations in School Branch headwaters are low (0.025 to 0.050 mg/L) and increase downstream to ~0.100 mg/L, while in 2005, the concentration at Station SB 7 is much higher than observed in 2004, but the rest of the stations downstream are similar to 2004 results. Along Fishback Creek, concentrations only slightly increase toward Eagle Creek Reservoir with the exception of the wet season event sampling of 2005 (Figure 8). During the 2005 wet season sampling, concentrations quickly drop quickly after Station

FC 5 and by FC 4 phosphate was non-detect. During wet season base flow, concentrations observed during 2004 decrease from the headwaters toward Eagle Creek Reservoir and are higher than those recorded during 2005. Wet season base flow 2005 phosphate concentrations have little downstream variation and many are not detected.

Dissolved Organic Carbon

Dissolved organic carbon concentrations were highest during the dry season at event flow conditions (Table 7). Dry season event flow mean and range were 8.10 mg/L and 4.79 to 13.30 mg/L. Dissolved organic carbon concentrations were the lowest during wet season base flow with a mean and range of 3.06 mg/L and 1.83 to 4.15 mg/L (Table 7). During the dry season, DOC concentrations are highly variable at ponded stations, whereas downstream concentrations are more similar for both watersheds during all conditions. During the wet season, base and event flow samplings show different downstream trends between the two watersheds. On School Branch during all wet season base flow samplings, there is little downstream variation, whereas on Fishback Creek DOC concentrations increase in the headwaters to Station 5 and then decrease from Station 5 toward Eagle Creek Reservoir (Figure 8). During wet season event flow conditions, different downstream trends are also observed on Fishback Creek versus School Branch. Along School Branch, DOC concentrations increase in the headwaters and then decrease toward Eagle Creek Reservoir in both the 2004 and 2005 events. However, on Fishback Creek, trends are different for the 2004 and 2005 events. In 2004, DOC concentrations increase downstream. However in 2005, DOC concentrations decrease downstream (Figure 8).

DISCUSSION

Source of Hydrologic Input

Discharge, percent water contribution, depth of runoff, silica, and Na:Cl ratios were used to understand the primary sources of hydrologic input to the streams. Potential errors in discharge should be noted. Due to these errors discharge was only assessed spatially. Examination of these parameters in combination indicates that hydrologic inputs vary seasonally and with respect to flow regime. Additionally, each watershed is uniquely influenced by land use and land cover characteristics.

Wet Season

During the wet season, sources of water vary with respect to flow regime. Additionally, percent contribution and major ion chemistry further suggest different sources of water in the lower reaches of School Branch and Fishback Creek during event flow.

Event Flow Conditions

During event flow conditions, high percent contributions in the headwater regions of Fishback Creek and School Branch suggest that the majority of water to the stream comes from the headwater regions (Table 8). These regions are predominantly in agricultural land use (Figure 5). Additionally, SiO_2 concentrations in the headwater regions range from 7.00 to 11.00 mg/L (Figure 7). In-stream silica concentrations suggest that these waters are at least partially sourced from groundwater sources, because incident precipitation is assumed to contain little or no dissolved silica, whereas in water that infiltrates soil dissolved silica concentrations rapidly increase due to equilibrium reactions (Buttle and Peters, 1997 and Kennedy et al., 1986). Furthermore, low (less than 1.00) Na:Cl ratios and low chloride concentrations (~20.00 mg/L) indicate that this water source is related to agricultural drainage (Waldron and Bent, 2001). Agricultural waters with groundwater characteristics that are rapidly delivered to the two streams are likely sourced from tile drainage systems.

In School Branch, agricultural tile drainage signals dominate the stream from the headwater to Eagle Creek Reservoir, correlating with the amount of agriculture upstream (Figure 5). However, in Fishback Creek around Station FC 5, a low silica water source is added to the stream lowering in-stream silica concentrations, while Na:Cl ratios increase to ~1.00 and chloride concentrations reach approximately 60.0 mg/L downstream, approaching Eagle Creek Reservoir (Figure 7). A potential source of low silica water to the stream is surface runoff, which could be easily and readily generated in the lower reaches of Fishback Creek due to the increased impervious surfaces in the region (Table 6).

While the majority of water in the stream is sourced from the agricultural headwaters of both streams, depth of runoff increases downstream as the amount of development increases indicating that amount of runoff is correlated to the amount of development (Figure 5 and Table 9). Similar observations have been widely documented in studies, and it is well known that developed lands and associated impervious surface coverage generate increased amounts of runoff. Developed lands have larger percentages of impervious surface, allowing waters to travel directly to nearby streams with little or no soil infiltration potential. The downstream increase in runoff generated in Fishback Creek is larger than observed in School Branch. The larger increase in Fishback Creek Watershed is likely due to the large increase in slope closer to Eagle Creek Reservoir. Furthermore, Na:Cl ratios in both streams increase as the amount of development upstream of each station increases (Figures 5 and 7). Increases in Na:Cl ratios could be sourced from septic systems and are a result of water softener salt usage, while increases in chloride input is also expected as it is used in large quantities to treat municipal water. In Fishback Creek, Na:Cl ratios approach 1.00, suggesting that developed land use has become the dominant influence on source water to the lower reaches of Fishback Creek. In School Branch, agricultural drainage appears to dominate the stream.

Base Flow Conditions

Highly variable downstream percent contributions to both streams during base flow conditions suggest that water input is not influenced by land use type (Figures 5 and 7). Constant downstream silica concentrations along both streams indicate that stream flow is sourced from groundwater discharge (Figure 7). However, SiO_2 concentrations were nearly twice those observed in 2005 during the wet season at base flow. Variations in silica concentration with respect to sample date are likely a result of evaporation and concentration of in-stream silica during the 2004 sampling. This is plausible as the 2004 sampling took place later in the summer, when in-stream evaporation is higher.

Na:Cl ratios and chloride concentrations further suggest groundwater sources of input to the two streams. On Fishback Creek, Na:Cl ratios and chloride trends are similar to event conditions, increasing as the amount of development upstream of the station increases (Figures 5 and 7). Again this suggests septic system discharge and residential water inputs. Thus, urban influences are apparent during the wet season at both base and event flow regimes. However on School Branch, Na:Cl ratios and chloride concentrations are highly variable downstream, with Na:Cl measuring close to 1.00 at isolated stations. These isolated peaks in Na:Cl ratios may be due to rural septic discharges (Figures 5 and 7). Signs of rural septic discharges along both streams were common. Event data suggest that theses inputs are then overwhelmed by large sources of agricultural drainage during event flow conditions.

Dry Season

During the dry season, percent contribution to stream flow during both base and event flow conditions is highest in the downstream reaches of the stream. In School Branch, the majority of water input comes from the region below Station SB 3, while in Fishback Creek reaches below Stations FC 5 and FC 6 contributed the majority of water to the stream (Table 8). During the dry season there is precipitation. As a result the water table drops, and the streams receive less input from groundwater and overland flow. This observation could also relate to the low soil moisture content in the agricultural headwater regions of both streams. Low soil moisture content are not experienced as severely in developed regions due to lawn irrigation practices, raising the groundwater table is these areas. Additionally, in this study the areas with higher amounts of development typically have steeper sloped topography, compounding the surfaces ability to generate runoff (Tables 5 and 6). As a result little input is observed from the agricultural reaches, whereas areas with more development contribute more water to the stream.

Moderate to high silica concentrations in flowing reaches of the streams suggest that the majority of input to both streams is sourced from groundwater (Figure 7). Ponded upstream stations have highly variable silica concentrations which could be a result of evaporation or biological uptake of silica by microorganisms (Allan, 1995).

Chloride concentrations again show some separation of the two watersheds during flowing conditions. Fishback Creek has higher chloride concentrations than School Branch closest to Eagle Creek Reservoir (Figure 7), suggesting more influence of development on Fishback Creek than School Branch. However, on School Branch chloride trends differ from the wet season. During the dry season, chloride increases downstream rather than decreasing (Figure 7), further suggesting that during the dry season developed regions have a larger impact on School Branch than during the wet season. Na:Cl are relatively close to 1.00 for both base and event conditions from the headwaters to Eagle Creek Reservoir for most samplings suggesting that septic discharge is again the primary source of discharge to the streams (Figure 7). The one exception being on School Branch during event conditions, where in-stream Na:Cl ratios less than 1.00 indicate agricultural drainage as an important source of water to the stream.

Land Use and Water Quality Relationships

Nitrate

Nitrate concentrations in Fishback Creek never exceeded the US EPA drinking water threshold for human toxicity of 10 mg N/L. However, on School Branch during wet season event flow conditions this standard was exceed at nearly all of the stations 100% of the time. While concentrations of NO_3 in samples collected from Fishback Creek did not exceed EPA standards for human toxicity, they were much higher than those of other watersheds in the region. A study completed in neighboring Kentucky reported a mean concentration of 1.57 mg/L NO_3-N for an entirely agricultural watershed (Coulter et al., 2004). In School Branch, whose waters are sourced almost entirely from agricultural drainage, NO_3-N concentrations were reported as high as 20.00 mg/L. Moreover, the mean NO_3-N concentration reported in this study is over twice that of agricultural regions in the Coulter study (Coulter et al., 2004). In 2000, Clark et al. reported a mean NO_3-N concentration of 0.09 mg/L for natural, undeveloped basins in the temperate regions of the U.S. Thus, both School Branch and Fishback Creek clearly experience above normal in-stream NO_3-N concentrations.

During the dry season, NO_3-N loading to the streams is minimal as concentrations are below detection limit nearly all of the time (Figure 8). However, during the wet season at both base and event flow regimes, strong relationships between land use and in-stream NO_3-N concentration are apparent. During event flow, both watersheds have similar headwater sources of NO_3-N, and NO_3-N concentrations are high and decrease downstream, indicating a headwater source. In addition, NO_3-N concentrations are similar to the percent of agriculture upstream of each station (Figures 5 and 8). NO_3-N concentrations on School Branch are greater than those on Fishback Creek and these higher concentrations persist to Eagle Creek Reservoir (Figure 8). On Fishback Creek, NO_3-N decreases rapidly and levels out around Station FC 4. These observations correspond to major land cover changes along the stream, suggesting that land use is the primary factor influencing NO_3-N delivery to the streams (Figure 5). Observations from the source water analysis also support the NO_3-N trends. Agriculture is the primary land use in School Branch and high NO_3-N concentrations likely sourced from agricultural fertilizers overwhelm the stream, and source water indicators also indicate that the majority of water in School Branch is sourced from agricultural drainage during event conditions. On Fishback Creek, the majority of agriculture is located above Station FC 6, after which the dominant land cover types are forested and developed and the majority of stream reaches have adequate woody riparian buffer (Figure 5). Downstream, high agricultural NO_3-N concentrations are diluted by low NO_3-N urban and temperate forest drainage, reducing NO_3-N concentrations to approximately 4.00 mg/L. While NO_3-N concentrations are diluted by the lower NO_3-N water input, the dilution is not enough to return the concentrations to that of natural waters as reported by Coulter et al. (2004) and Clark (1980). The downstream dilution of NO_3-N indicates that a source or sources of low NO_3-N waters are entering the stream. The location of the dilution along the stream corresponds to a land use change from agricultural to urban land use with a riparian buffer. The dilution could be a result of riparian uptake of NO_3-N, decreased input associated with residential urban land use, or a combination of both factors. However, low SiO_2 concentrations indicate that the source waters have little contact with the subsurface, indicating that it is likely urban influences not riparian buffer denitrification processes influencing observed NO_3-N decreases.

Phosphate

The mean PO_4 concentration in this study is more than twice that for other agricultural lands in the region, as reported by Coulter et al. in 2004. Coulter et al. (2004) found that agricultural lands have a mean PO_4 concentration of 0.05 mg/L, while mixed and urban waters have a mean PO_4 concentration of approximately 0.02 mg/L. In fact, PO_4 concentrations in this study frequently surpassed 0.03 mg/L. Streams with PO_4 concentrations higher than 0.03 mg/L are likely to cause eutrophication (Stevens et al., 1999). These data indicate that on both Fishback Creek and School Branch there are extraneous sources of PO_4 loading to the streams.

Downstream PO_4 trends did not show any strong relationships to land cover within either watershed (Figures 5 and 8). During all sampling conditions, little downstream variation in PO_4 concentration was observed, with the exception of Fishback Creek during the 2005 wet event sampling. The lack of variation in PO_4 downstream indicates that both agricultural and residential land use areas affect the loading of PO_4 to streams similarly. This observation contradicts that observed by Coulter et al. (2004), as they found that in-stream PO_4 concentrations in urban watersheds were higher than those observed in agricultural watersheds. Likewise, predicted increases in development and decreases in agricultural acreage will have little effect on PO_4 loading to the streams and Eagle Creek Reservoir. Additionally, there were no decreases in PO_4 concentration that correlated to increased buffer, indicating that riparian buffer present along the stream does not adequately filter PO_4 from runoff or groundwater.

Dissolved Organic Carbon

The average concentration of DOC in temperate rivers is approximately 3.0 mg/L (Berner and Berner, 1987). During the event flow conditions in both the dry season and wet season, concentrations of DOC in Fishback Creek and School Branch frequently exceed 3.0 mg/L (Figure 8). However, during the wet season base flow DOC concentrations in both streams were approximately 3.0 mg/L. The lower DOC and SiO_2 concentrations indicate that wet season groundwater input is not a significant source of DOC. High DOC concentrations observed in the dry season are likely due to decreased water input to the streams. Likewise, they could also result from increased DOC input from fall leaf litter. During the dry months, especially in the fall, stream waters were dark brown from decaying leaf litter indicating that an abundance of carbon may be in the water. Similarity in DOC concentration in the headwaters and near Eagle Creek Reservoir indicate that similar amounts of DOC is input to the stream in these regions. Thus, in the studied watershed, developed, agricultural, and forested land covers do not appear to control DOC concentrations in the streams during the dry season or during wet season base flow conditions.

During the wet season, in School Branch Creek, downstream decreasing DOC trends indicate a dominant headwater DOC source, likely agriculture, the primary land cover in the region (Figure 5). On Fishback Creek, differing trends in 2004 and 2005 may be linked to the timing of the events. In 2005, DOC decreased downstream, indicating that the dominant DOC source was likely agricultural drainage. The 2005 event took place in early spring, prior to planting in the agricultural areas and before forest canopies had fully developed. It follows that a likely source of DOC to the stream would be debris on newly turned fields in the headwater regions of Fishback Creek. The 2004 sampling, took place in late spring, when agricultural fields were planted and there was less chance of eroding organic matter reaching streams. Thus, the observed downstream increase in DOC concentrations in the lower reaches of Fishback Creek in 2004 are likely sourced from urban inputs that could potentially be septic discharge, litter from the forested reaches of the stream, and suburban landscaping such as mulch and leaf clippings.

CONCLUSION

By examining several chemical components of stream water (SiO_2, Cl^-, Na^+, NO_3-N, PO_4, and DOC) this study allowed for a better understanding of the delivery of water and nutrients to temperate streams. These parameters have proven successful in tracing source water to the streams and determining the effects of land cover on in-stream nutrient and other chemical concentrations.

Easily analyzed and cost effective parameters including discharge, silica, sodium, and chloride proved to be adequate source water tracers. Silica concentrations adequately identified sources of groundwater to the two temperate streams, while Na:Cl ratios proved effective in distinguishing agricultural from urban source waters. During wet season event flow conditions, School Branch is dominated by agriculturally sourced tile drainage, whereas during wet season base flow urban and rural development sources can be identified in the lower reaches of the stream. During the wet season, Fishback Creek headwaters are dominated by agricultural tile drainage during base and event flow conditions, while downstream reaches are primarily influenced by urban sources. Downstream urban sources are likely runoff during event conditions and septic discharges during base flow conditions. Dry season results indicate that groundwater discharge from developed land cover regions are the primary source of water to both streams.

Like source water to the stream, in-stream nutrient concentrations also exhibited strong relationships with land cover. As seen in School Branch, large percentages of agricultural land cover and very little adequate buffer in the headwater reaches of streams results in high NO_3-N, PO_4, and DOC concentrations overwhelming the stream with an agricultural signal even when other land cover types are present along stream reaches. As a result, NO_3-N concentrations on School Branch during the wet season surpassed the US EPA drinking water standard for NO_3-N and are unsafe for human or wildlife consumption. Trends observed on Fishback Creek indicate that decreased NO_3-N loads may be observed as development increases in the watershed. In addition, the current dilution of NO_3-N concentrations observed along Fishback Creek in urban reaches is not strong enough to reduce the agricultural signals to natural levels before waters enter into Eagle Creek Reservoir. Observations in Fishback Creek further indicate that a land cover change from agricultural land cover to development will have little effect on in-stream PO_4 and DOC concentrations. However, future land cover changes from agriculture to development could potentially reduce in-stream NO_3-N concentrations and loading to streams and Eagle Creek Reservoir.

TABLES

Table 1. Monthly rainfall and percentage of rainfall occurring during each month throughout the course of the study (April 2004 to April 2005).

	Month and Year													
	A-04	**M-04**	**J-04**	**J-04**	**A-04**	**S-04**	**O-04**	**N-04**	**D-04**	**J-05**	**F-05**	**M-05**	**A-05**	**Total**
Inches of rainfall	1.47	5.62	2.43	5.06	2.85	0.43	3.84	4.75	1.40	7.28	2.32	1.42	4.43	43.28
Centimeters of rainfall	3.74	14.27	6.16	12.84	7.25	1.09	9.76	12.06	3.56	18.49	5.9	3.61	11.24	109.94
Percent of Total	3.40%	12.98%	5.60%	11.68%	6.59%	0.99%	8.88%	10.97%	3.24%	16.82%	5.37%	3.28%	10.22%	

Table 2. Indiana Department of Natural Resources percent no-till, mulch-till, and conventional-till for corn and soy acreage in Hendricks and Boone Counties, and Rank of percent no-till acreage for corn and soy out of 90 counties (IDNR, 2004).

		Corn		
County	**No-till**	**Mulch-till**	**Conventional**	**Rank**
Hendricks	28%	32%	41%	31
Boone	7%	11%	82%	74

		Soy		
County	**No-till**	**Mulch-till**	**Conventional**	**Rank**
Hendricks	77%	22%	1%	16
Boone	66%	18%	16%	37

Table 3. Watershed, date, season, and flow regime of all periods of sample collection (When sampling occurred more than once in a watershed during the same calendar year for the same season and flow regime, the first occurrence is labeled A and the second B. Sampling event designation corresponds with Figures 6, 7, and 8.)

Sampling Event Designation	Watershed	Date	Season	Flow Regime
FC WB-a	Fishback Creek	5/12/2004	Wet	Base
SB WB-a	School Branch	6/9/2004	Wet	Base
SB WE-a	School Branch	6/11/2004	Wet	Event
SB WE-b	School Branch	6/11/2004	Wet	Event
FC WE-a	Fishback Creek	6/16/2004	Wet	Event
FC WE-b	Fishback Creek	6/17/2004	Wet	Event
FC DB-a	Fishback Creek	9/9/2004	Dry	Base
SB DB-a	School Branch	9/15/2004	Dry	Base
SB DB-b	School Branch	10/13/2004	Dry	Base
FC DE-a	Fishback Creek	10/15/2004	Dry	Event
SB DE-a	School Branch	11/2/2004	Dry	Event
FC DE-b	Fishback Creek	11/2/2004	Dry	Event
FC WB-b	Fishback Creek	3/21/2005	Wet	Base
SB WB-b	School Branch	3/21/2005	Wet	Base
FC WE-c	Fishback Creek	4/22/2005	Wet	Event
SB WE-c	School Branch	4/22/2005	Wet	Event

Table 4. Method description, EPA standard method designation, detection limit, and percent error for dissolved silica, chloride, sodium, nitrate, phosphate, and dissolved organic carbon.

Analysis	Method Description	EPA Method	Detection limit	Percent Error
Dissolved Silica	Colorimetric	370.1	0.10 mg SiO_2/L	0.94%
Chloride	Ion chromagraphy	300.0	8.00 mg Cl/L	0.96%
Sodium	Ion chromagraphy	ASTM D 6919	1.00 mg Na/L	2.72%
Nitrate	Ion chromagraphy	300.0	0.10 mg N/L	1.33%
Phosphate	Ascorbic acid method	SM 4500-P E	0.005 mg P/L	1.81%
Dissolved Organic Carbon	Persulfate-ultraviolet oxidation to CO_2	SM 5310C	0.50 mg C/L	4.06%

Table 5. Between station areas and total areas (km^2) and percent of between station areas and total areas of high, low, and total development, forest, herbaceous (grassland), agriculture, and open water identified in each watershed in 2002-2003.

Watershed Region	Total Area	High Density Development		Low Density Development		Total Development		Forest		Herbaceous (Grassland)		Agriculture		Open Water	
	km^2	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%
FC 2 to FC 1	0.48	0.00	0.00%	0.01	2.71%	0.01	2.71%	0.35	72.09%	0.10	21.19%	0.04	8.53%	0.01	2.84%
FC 3 to FC 2	6.67	0.02	0.23%	0.79	11.82%	0.80	12.05%	1.99	29.83%	1.27	19.04%	2.65	39.64%	0.08	1.16%
FC 4 to FC 3	5.02	0.14	2.71%	0.68	13.61%	0.82	16.32%	1.50	29.94%	1.21	24.10%	1.39	27.75%	0.10	1.92%
FC 5 to FC 4	6.76	0.31	4.58%	1.24	18.30%	1.55	22.88%	0.93	13.73%	1.52	22.53%	2.74	40.54%	0.06	0.92%
FC 6 to FC 5	7.54	0.03	0.43%	1.04	13.81%	1.07	14.24%	1.09	14.43%	1.46	19.37%	3.60	47.76%	0.07	0.96%
FC 7 to FC 6	7.88	0.02	0.22%	0.36	4.58%	0.38	4.81%	1.30	16.50%	0.85	10.76%	5.26	66.68%	0.00	0.06%
FC 8 to FC 7	10.20	0.03	0.26%	0.31	3.05%	0.34	3.31%	0.36	3.51%	0.91	8.93%	8.65	84.76%	0.01	0.07%
Upstream of FC 8	13.29	0.22	1.67%	0.35	2.64%	0.57	4.31%	0.78	5.86%	1.12	8.41%	10.92	82.19%	0.06	0.48%
Watershed Total	58.77	0.75	1.28%	4.78	8.14%	5.54	9.42%	8.95	15.22%	8.51	14.48%	35.05	59.65%	0.54	0.91%
SB 2 to SB 1	5.22	0.00	0.00%	1.09	20.92%	1.09	20.92%	0.99	18.94%	1.14	21.93%	1.79	34.22%	0.08	1.62%
SB 3 to SB 2	3.09	0.00	0.00%	0.82	26.48%	0.82	26.48%	0.08	2.61%	0.08	2.61%	1.64	53.04%	0.07	2.13%
SB 4 to SB 3	1.22	0.00	0.20%	0.00	0.20%	0.01	0.41%	0.05	3.73%	0.13	10.32%	1.04	84.67%	0.00	0.20%
SB 5 to SB 4	2.56	0.00	0.02%	0.03	1.00%	0.03	1.03%	0.02	0.61%	0.19	7.30%	2.42	94.53%	0.00	0.00%
SB 6 to SB 5	2.51	0.00	0.00%	0.06	2.37%	0.06	2.37%	0.00	0.15%	0.16	6.34%	2.33	92.86%	0.00	0.00%
SB 7 to SB 6	3.83	0.00	0.00%	0.09	2.25%	0.09	2.25%	0.11	2.76%	0.23	5.94%	3.49	91.05%	0.00	0.08%
Upstream of SB 7	4.77	0.00	0.04%	0.30	6.22%	0.30	6.26%	0.32	6.64%	0.60	12.62%	3.65	76.48%	0.01	0.20%
Watershed Total	25.03	0.01	0.02%	2.38	9.50%	2.38	9.52%	1.56	6.22%	2.53	10.09%	16.34	65.26%	0.17	0.66%

Table 6. Total and between station percentages of adequate buffer and mean and maximum percent slope along the School Branch and Fishback Creek Watershed stream reaches.

Watershed Region	Adequate Buffer Along Stream Reach	Mean Slope	Maximum Slope
FC 2 to FC 1	100.0%	4.1%	23.8%
FC 3 to FC 2	94.2%	2.4%	23.3%
FC 4 to FC 3	94.1%	2.5%	20.7%
FC 5 to FC 4	98.6%	1.6%	17.2%
FC 6 to FC 5	71.0%	1.3%	10.8%
FC 7 to FC 6	100.0%	1.1%	9.5%
FC 8 to FC 7	18.7%	0.6%	5.6%
Upstream of FC 8	0.0%	0.5%	5.5%
Watershed Total	65.7%	1.3%	23.8%
SB 2 to SB 1	97.4%	1.5%	17.4%
SB 3 to SB 2	7.4%	0.6%	7.4%
SB 4 to SB 3	23.4%	0.6%	4.5%
SB 5 to SB 4	10.6%	0.5%	4.0%
SB 6 to SB 5	0.0%	0.4%	2.9%
SB 7 to SB 6	9.0%	0.4%	2.6%
Upstream of SB 7	0.0%	0.3%	2.4%
Watershed Total	33.5%	0.9%	17.4%

Table 7. Mean and range of discharge, dissolved silica, chloride, Na:Cl ratios, nitrate, dissolved organic carbon, and phosphate for wet and dry season base and event flow conditions. The dry season for the study period was from June 28, 2004 to December 6. 2004, while base flow was based on a 40 year average of discharge records from the USGS gauging station in Zionsville, Indiana and event flow was defined as at least three times the base flow discharge.

		Wet Season Base		Wet Season Event		Dry Season Base		Dry Season Event	
Parameter	**Watershed**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**
Discharge	**Both**	0.07	0.00 - 0.42	3.22	0.37 - 9.59	0.00	0.00 - 0.01	0.13	0.00 - 0.41
(m^3/s)	**Fishback Creek**	0.11	0.02 - 0.42	2.87	0.72 - 4.93	0.00	0.00 - 0.01	0.11	0.00 - 0.26
	School Branch	0.03	0.00 - 0.07	3.63	0.37 - 9.59	0.00	0.00 - 0.01	0.21	0.05 - 0.41
Dissolved Silica	**Both**	5.43	0.79 - 11.94	8.63	3.39 - 11.00	9.17	4.94 - 13.69	8.68	2.61 - 12.60
(mg/L)	**Fishback Creek**	5.41	0.79 - 11.94	8.09	3.39 - 11.00	7.84	4.94 - 11.90	8.48	2.61 - 12.60
	School Branch	5.45	1.06 - 11.00	9.24	6.71 - 10.70	10.14	7.37 - 13.69	9.17	7.82 - 10.40
Chloride	**Both**	37.63	21.67 - 58.59	21.98	14.13 - 48.57	52.86	23.36 - 158.68	41.43	16.36 - 90.60
(mg/L)	**Fishback Creek**	43.25	31.40 - 58.59	25.99	18.00 - 48.57	50.69	23.36 - 72.49	47.34	16.36 - 90.60
	School Branch	31.21	21.67 - 42.47	17.39	14.13 - 23.11	54.44	24.52 - 158.68	26.63	20.22 - 37.18
Na:Cl	**Both**	0.45	0.32 - 0.58	0.43	0.28 - 0.63	0.51	0.36 - 0.73	0.57	0.25 - 1.34
	Fishback Creek	0.48	0.37 - 0.58	0.48	0.35 - 0.63	0.57	0.36 - 0.73	0.57	0.36 - 0.73
	School Branch	0.41	0.32 - 0.52	0.35	0.28 - 0.43	0.46	0.36 - 0.57	0.45	0.25 - 0.60
Nitrate	**Both**	3.48	0.50 - 9.28	9.85	2.11 - 19.40	1.10	0.86 - 1.50	0.67	0.00 - 5.48
(mg/L)	**Fishback Creek**	1.85	0.50 - 3.83	5.48	2.11 - 9.79	1.00	1.00 - 1.00	0.57	0.00 - 1.00
	School Branch	5.33	1.97 - 9.28	14.64	8.98 - 19.40	1.17	0.86 - 1.50	0.91	0.00 - 5.48
Phosphate	**Both**	0.15	0.10 - 0.20	0.17	0.10 - 0.20	0.25	0.10 - 0.77	0.09	0.00 - 0.20
(mg/L)	**Fishback Creek**	0.14	0.10 - 0.20	0.20	0.14 - 0.20	0.19	0.10 - 0.20	0.12	0.00 - 0.20
	School Branch	0.15	0.10 - 0.20	0.13	0.10 - 0.20	0.29	0.12 - 0.77	0.00	0.00 - 0.00
Dissolved	**Both**	3.06	1.83 - 4.15	5.93	4.37 - 7.25	7.51	3.13 - 22.40	8.10	4.79 - 13.30
Organic Carbon	**Fishback Creek**	3.46	2.44 - 4.15	5.79	4.37 - 7.24	5.68	3.13 - 10.60	5.68	3.13 - 10.60
(mg/L)	**School Branch**	2.61	1.83 - 3.05	6.09	5.22 - 7.25	8.85	4.55 - 22.40	6.09	4.79 - 7.10

Table 8. Mean percent of total discharge contributed to Fishback Creek and School Branch by each between station area during dry season and wet season event and base flow.

	Dry Event	Dry Base	Wet Event	Wet Base
Watershed Region	**Mean**	**Mean**	**Mean**	**Mean**
FC 2 to FC 1	-17.46%	100.00%	1.01%	-12.05%
FC 3 to FC 2	61.13%	0.00%	12.93%	-53.78%
FC 4 to FC 3	8.15%	0.00%	10.09%	89.62%
FC 5 to FC 4	8.42%	0.00%	12.21%	-20.22%
FC 6 to FC 5	20.17%	0.00%	14.10%	21.80%
FC 7 to FC 6	-1.44%	0.00%	13.96%	19.33%
FC 8 to FC 7	27.82%	0.00%	16.71%	37.96%
Upstream of FC 8	0.00%	0.00%	20.00%	24.39%
SB 2 to SB 1	41.28%	17.39%	31.86%	4.67%
SB 3 to SB 2	35.25%	82.61%	20.11%	31.10%
SB 4 to SB 3	6.97%	0.00%	8.10%	12.17%
SB 5 to SB 4	5.09%	0.00%	14.47%	3.97%
SB 6 to SB 5	2.72%	0.00%	13.40%	32.64%
SB 7 to SB 6	8.68%	0.00%	20.23%	13.28%
Upstream of SB 7	0.00%	0.00%	23.69%	6.85%
	Total	**Total**	**Total**	**Total**
Fishback Creek	106.80%	100.00%	101.01%	107.03%
School Branch	100.00%	100.00%	131.86%	104.67%

Table 9. Mean and standard deviation of depth of runoff (mm) contributed to Fishback Creek and School Branch by each between station area during dry season and wet season event and base flow.

	Dry Event	Dry Base	Wet Event	Wet Base
Watershed Region	**Mean**	**Mean**	**Mean**	**Mean**
FC 2 to FC 1	-8.20×10^{-09}	$-4.11E^{-09}$	$1.11E^{-08}$	$-4.85E^{-09}$
FC 3 to FC 2	$2.12E^{-09}$	$1.61E^{-09}$	$8.43E^{-09}$	$-1.61E^{-09}$
FC 4 to FC 3	$3.43E^{-10}$	$1.33E^{-11}$	$8.67E^{-09}$	$3.33E^{-09}$
FC 5 to FC 4	$3.18E^{-10}$	$4.65E^{-10}$	$7.80E^{-09}$	$-3.37E^{-10}$
FC 6 to FC 5	$5.85E^{-10}$	$1.95E^{-10}$	$8.08E^{-09}$	$4.14E^{-10}$
FC 7 to FC 6	$-4.00E^{-11}$	$-1.33E^{-11}$	$7.57E^{-09}$	$3.33E^{-10}$
FC 8 to FC 7	$1.30E^{-10}$	$4.32E^{-11}$	$7.02E^{-09}$	$2.47E^{-10}$
Upstream of FC 8	0.00	0.00	$6.32E^{-09}$	$2.05E^{-10}$
SB 2 to SB 1	$3.28E^{-09}$	$-4.31E^{-07}$	$3.09E^{-08}$	$5.37E^{-11}$
SB 3 to SB 2	$4.74E^{-09}$	$3.17E^{-07}$	$3.32E^{-08}$	$5.85E^{-10}$
SB 4 to SB 3	$2.36E^{-09}$	0.00	$3.49E^{-08}$	$5.44E^{-10}$
SB 5 to SB 4	$8.24E^{-10}$	0.00	$2.90E^{-08}$	$8.98E^{-11}$
SB 6 to SB 5	$4.51E^{-10}$	0.00	$6.58E^{-08}$	$7.50E^{-10}$
SB 7 to SB 6	$4.19E^{-10}$	0.00	$1.50E^{-08}$	$2.06E^{-10}$
Upstream of SB 7		0.00	$2.42E^{-08}$	$8.28E^{-11}$

FIGURES

Figure 1. Location of Eagle Creek Watershed in Central Indiana and sub-watersheds contained within Eagle Creek Watershed.

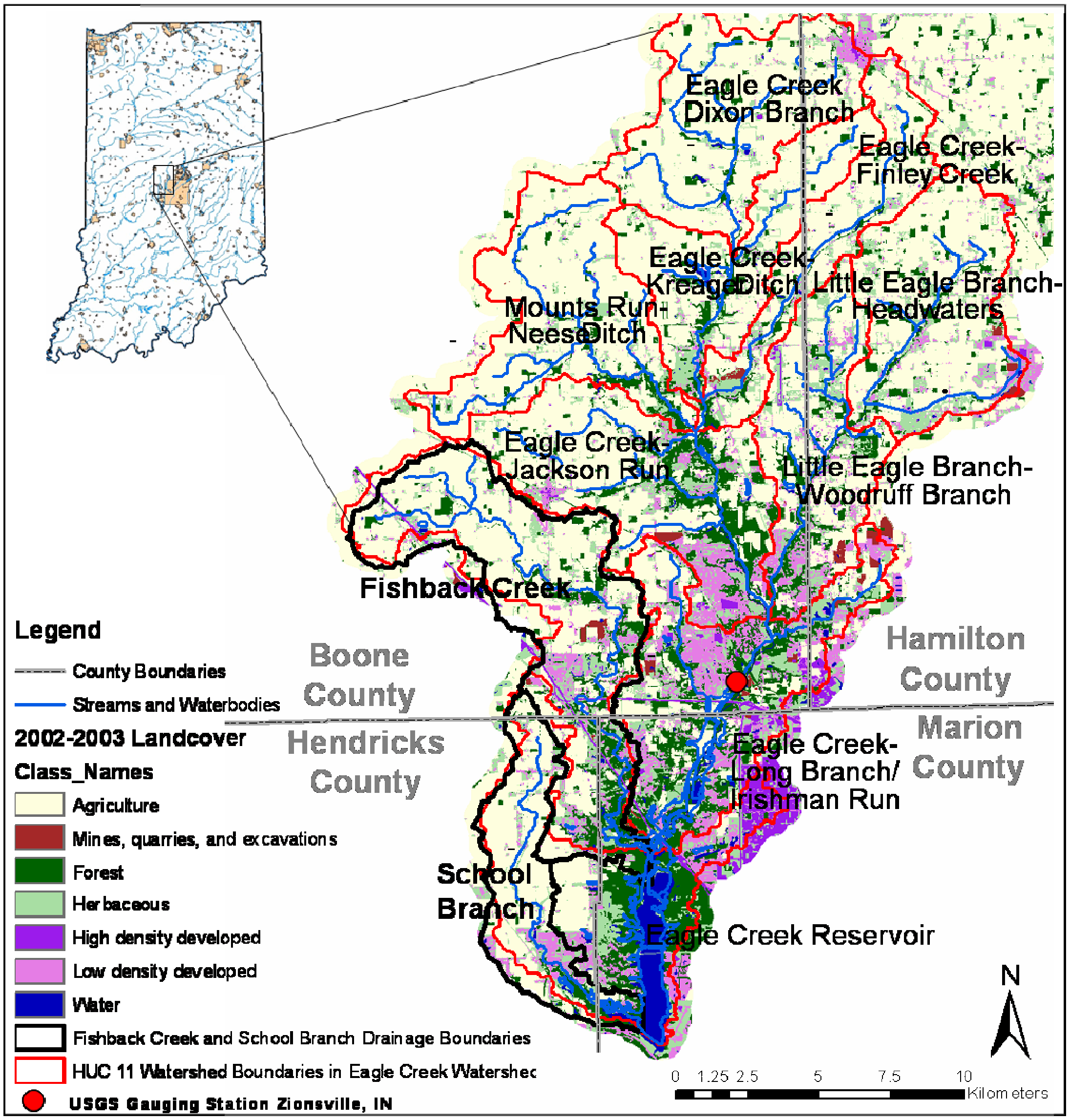


Figure 2. Double mass curve for the study period (precipitation (mm) recorded at the Eagle Creek Airport versus discharge (m^3/s) at the USGS Gauging Station in Zionsville, Indiana).

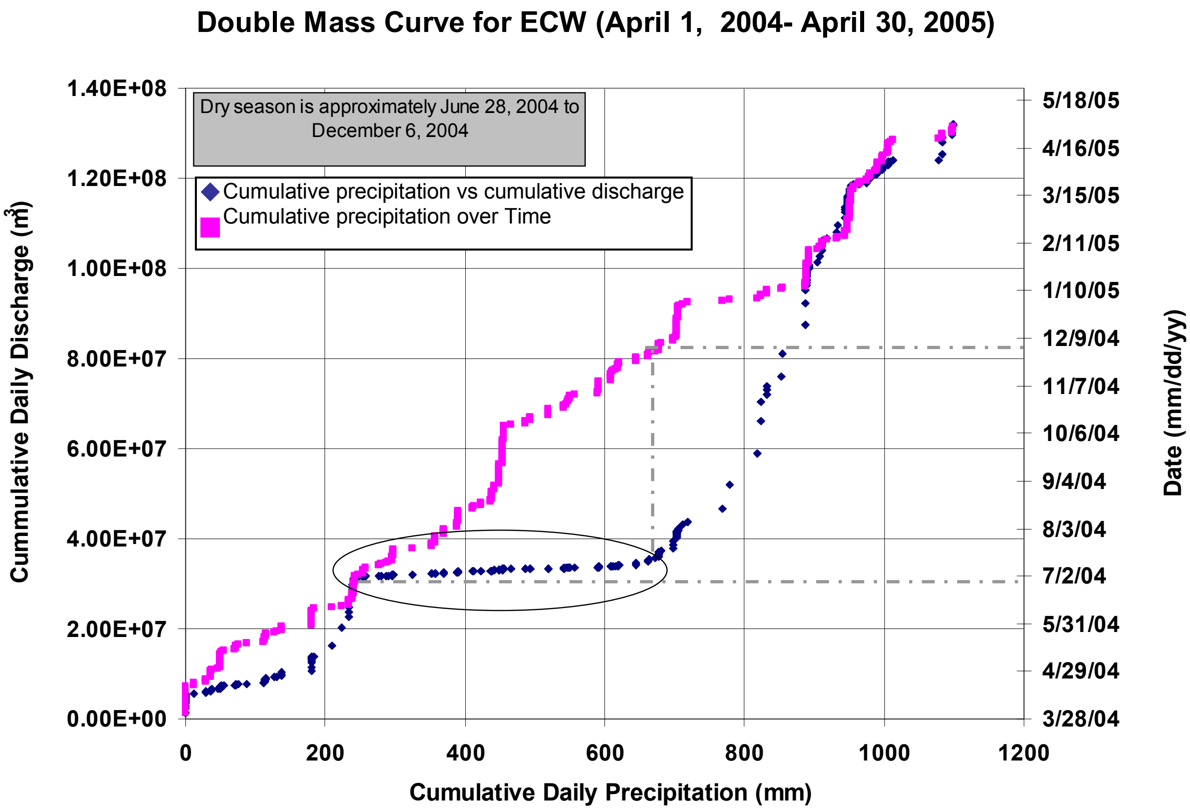


Figure 3. 2002-2003 land cover, sampling stations, and between station drainage areas in Fishback Creek and School Branch Watersheds

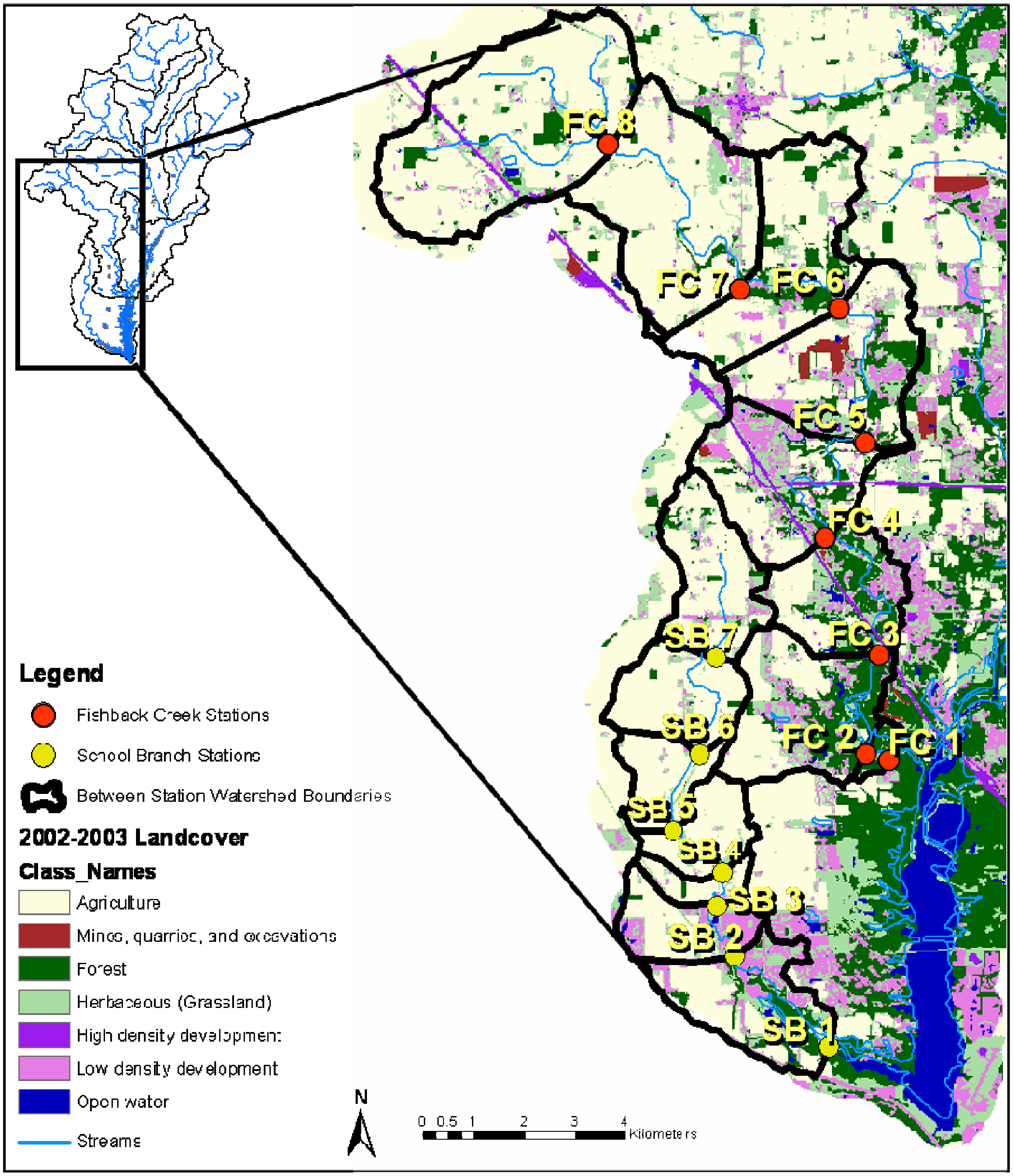


Figure 4. Delineation of School Branch and Fishback Creek watersheds using Arc GIS Hydrology Modeling Tools compared to USGS HUC 14 watershed boundaries.

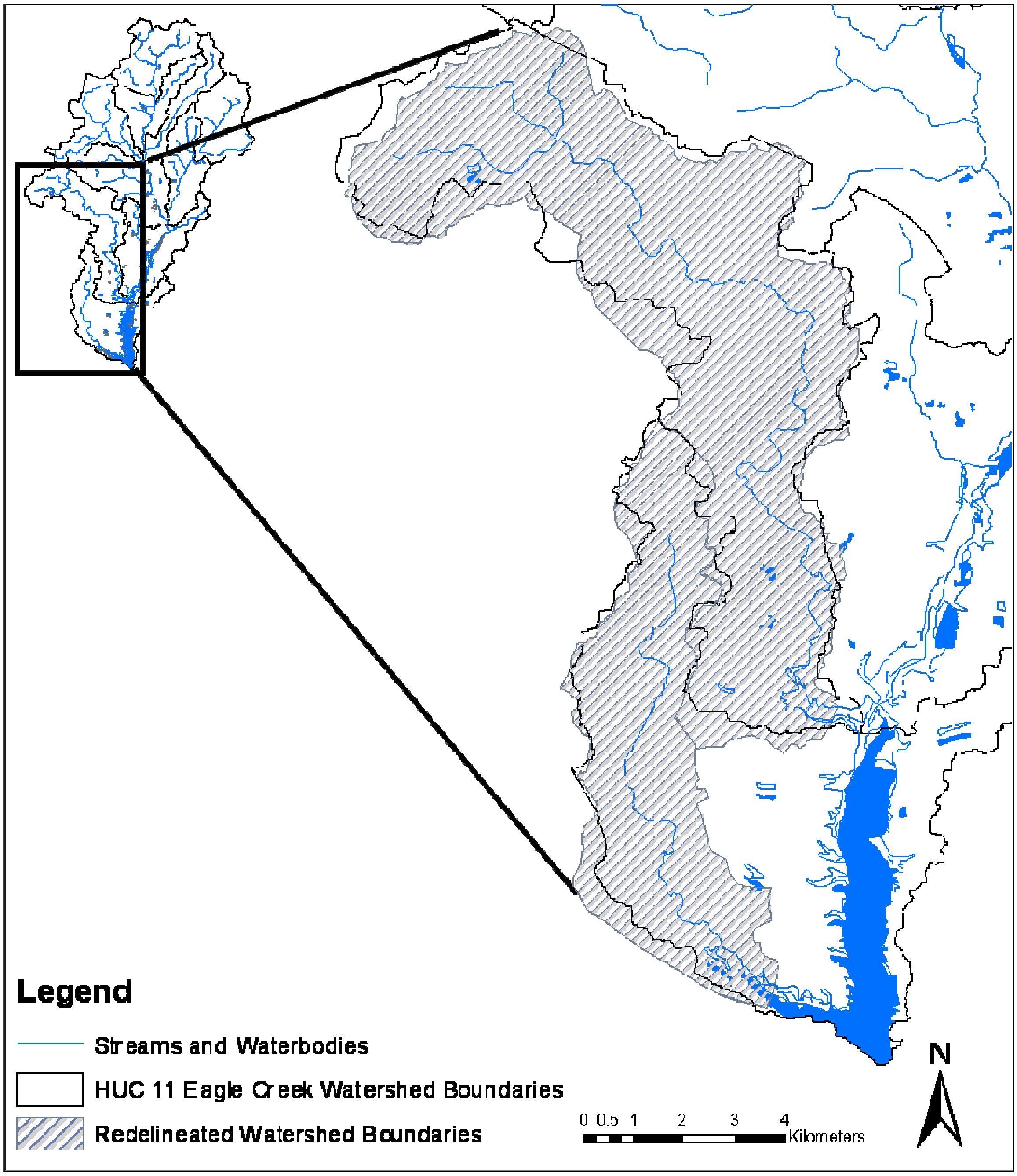


Figure 5. Histogram illustrating the percent of agricultural, forested, and developed land upstream of each sample station.

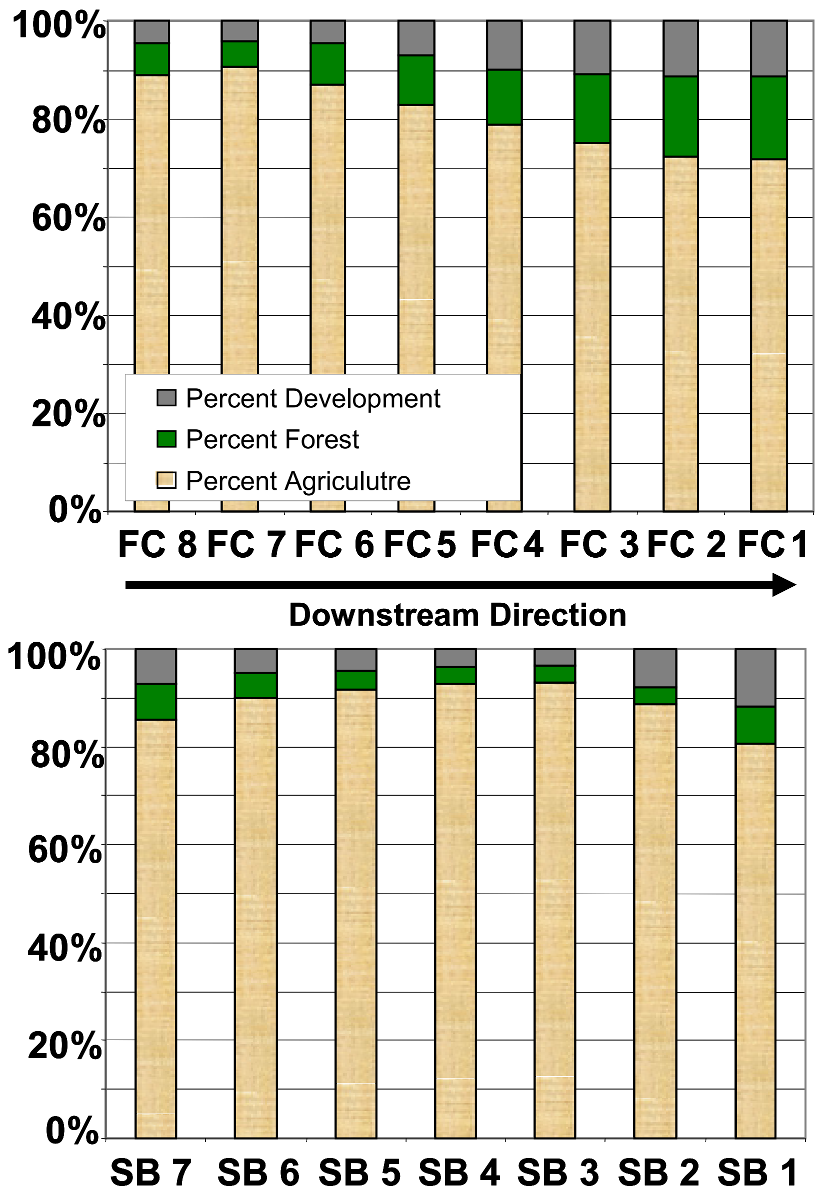


Figure 6. An example of downstream discharge trends. The graph data is event flow downstream discharge (m^3/s) for the June, October, and November 2004 sampling events. See Table 3 for watershed, date, season, and flow regime corresponding with the legend sampling event designation.

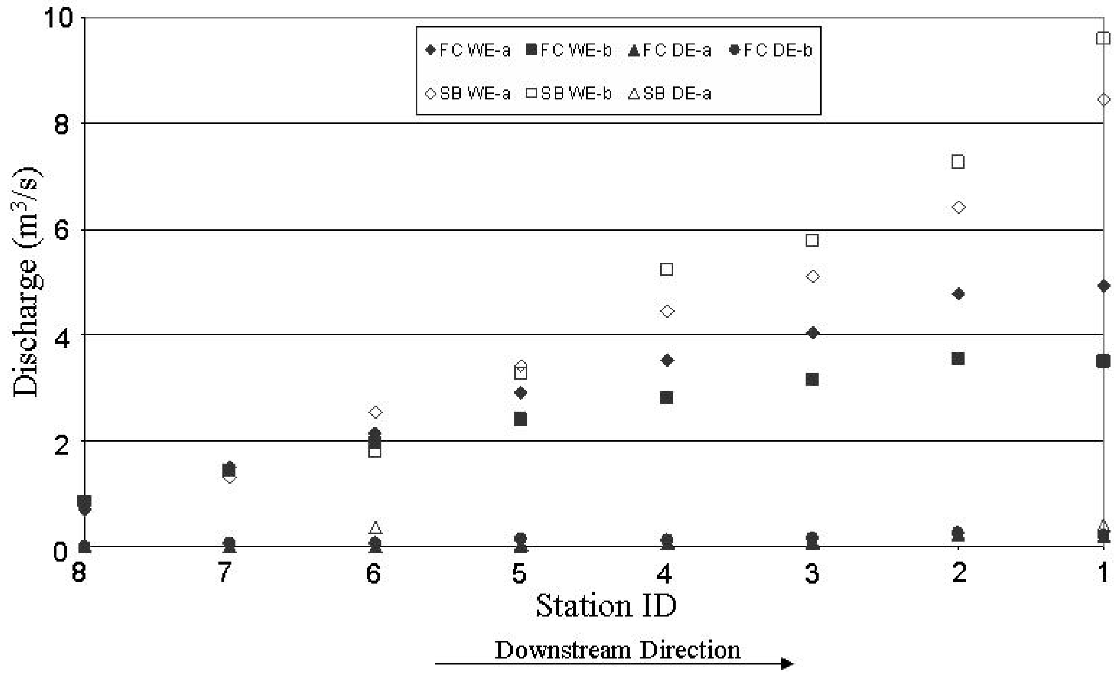


Figure 7. Downstream trends of dissolved silica, chloride, and Na:Cl ratios for School Branch and Fishback Creek during wet season and dry season base and event flow regimes. See Table 3 for watershed, date, season, and flow regime corresponding with the legend sampling event designation.

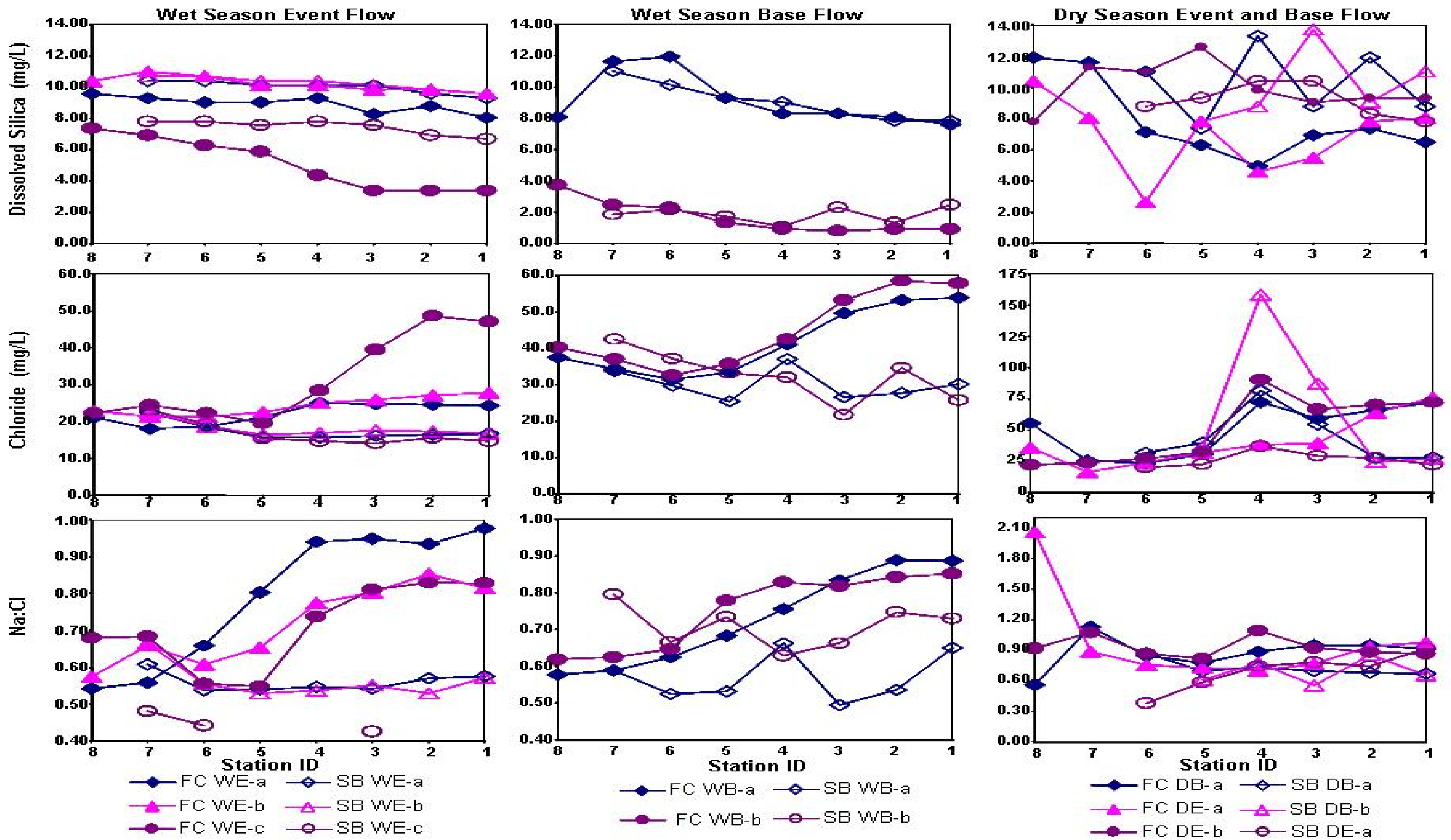
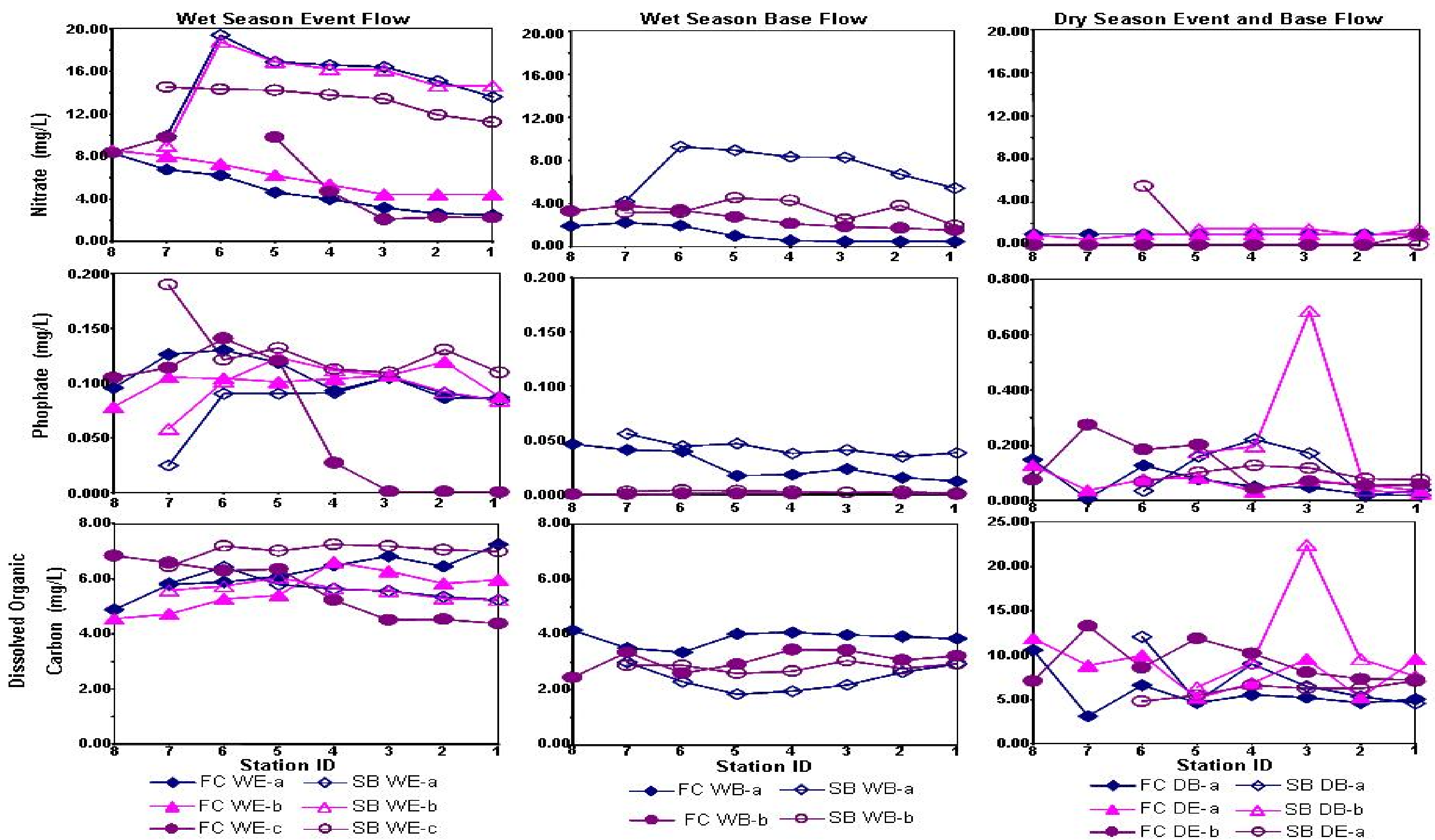


Figure 8. Downstream trends of dissolved nitrate, phosphate, and dissolve organic carbon for School Branch and Fishback Creek during wet season and dry season base and event flow regimes. See Table 3 for watershed, date, season, and flow regime corresponding with the legend sampling event designation.



APPENDICES

Appendix A. Extended Methods, Results, and Discussion for the SCS modified curve number discharge calculation

METHODS

The SCS curve number method (Stevens, 2004) was modified to estimate discharge during the June 2004 wet event samplings on both Fishback Creek and School Branch, because stream stage and velocity were to0 high to safely enter the streams. Calculations were completed by determining a curve number (CN) for the contributing area to each station and the area upstream of the Zionsville USGS gauging station on Eagle Creek. Each land use type was first assigned a CN value. The land use CN values for high density, low density, excavations, forest, herbaceous (grassland), agriculture, and water were 90, 79, 88, 70, 74, 88, and 0, respectively. A weighted CN was then determined using the percent of each land use type upstream of each station and the Zionsville USGS gauging station.

The SCS CN was then used to calculate the potential distraction for the area upstream of each station and the area upstream of the Zionsville USGS gauging station. The potential distraction and the total amount of rainfall associated with the sampling date was then used to estimate the total amount runoff that was generated upstream of each station during each event.

The estimated event runoff was then related to the instantaneous discharge measured at the Zionsville USGS gauging station to calculate the instantaneous discharge at each station along Fishback Creek and School Branch. Instantaneous discharge is measured at the Zionsville gauging station every 15 minutes. During the School Branch sampling, the discharge at the USGS gauging station ranged from approximately 75 to 108 m^3/s, while during the Fishback Creek Event A on 6/16/2004 sampling, it ranged from approximately 14 to 22 m^3/s. During Event B sampling on 6/17/2004, the range was from approximately 15 to 17 m^3/s. The calculation was completed by dividing the instantaneous discharge at the Zionsville gauging station by the estimated SCS curve number method runoff upstream of the Zionsville station. This number was then multiplied by the estimated event runoff upstream of each of the stations in Fishback Creek and School Branch.

However, the catchment area of the Zionsville USGS gauging station is very large compared to those of the stations along Fishback Creek and School Branch Creek. As a result, it was necessary to multiply the estimated instantaneous discharge upstream of the stations along Fishback Creek and School Branch Creek by a correction factor. The area upstream of the Zionsville station is approximately 102 square miles, while the Fishback Creek and School Branch catchment areas range from approximately 2 to 22 square miles. The correction factor was calculated by dividing the Zionsville station catchment area by the area upstream of each station along Fishback Creek and School Branch. The resulting number is the estimated instantaneous discharge for each station along Fishback Creek and School Branch.

To estimate the error associated with the calculation, instantaneous discharge was also estimated for the Event C sampling on 4/22/2005 using the modified SCS Curve Number Method. The estimated results were then compared to the in-stream measured instantaneous discharge collected on 4/22/2005. Downstream trends between estimated discharges and the actual instantaneous discharges collected during the 4/22/2005 sampling event were also compared. Error was also estimated from in-situ instantaneous discharge measurements collected at FC 8 on both 6/16/2004 and 6/17/2004.

RESULTS

The estimated discharge along on School Branch for Event A on 6/11/2004 ranged from 1.31 m^3/s at Station SB7 to 8.47 m^3/s at Station SB 1, for Event B it ranged from 1.79 m^3/s to 9.59 m^3/s. In Fishback Creek, the estimated instantaneous discharge at Station FC 8 on 6/16/2004 was 0.72 m^3/s, while at FC 1 it was 4.93 m^3/s. On 6/17/2004 during the Event B sampling the estimated instantaneous discharge on Fishback Creek ranged from 0.85 m^3/s at Station FC 8 to 3.49 m^3/s at Station FC 1. For the Event C sampling, estimated discharge ranged from 0.7 m^3/s to 1.85 m^3/s on School Branch and 0.95 m^3/s to 4.59 m^3/s on Fishback Creek.

The average percent error calculated from in-situ measurements at Station FC 8 on 6/16/2004 and 6/17/2004 was 27.56%. However, the difference between the measured and estimated discharges was 0.39 m^3/s on 6/16/2004 and –0.14 m^3/s on 6/17/2004.

Trend analysis of the 4/22/2005 data yielded an average slope value of approximately 5.22. The average error for all stations was 0.37% for the 4/22/2005 comparison. The error was approximately 0.31% for all stations except FC 6, which had an error of 1.21%.

DISCUSSION AND CONCLUSION

The extremely low error observed during the 4/22/2005 comparison analysis indicates that the calculation is robust and an effective way of measuring instantaneous discharge during an event along a stream when in-situ measurements cannot be collected. It also suggests that the calculation can be applied during both the wet and dry seasons and in watersheds with various sizes and land use characteristics. The source of error in the calculation at Station FC 6 is unknown. It is possibly due to a miscalculation of the SCS CN. The error could also be a result of error in the in-stream instantaneous discharge measurement collected on 4/22/2005.

Also, it is counter intuitive to have higher discharge on School Branch than on Fishback Creek during the wet season, since Fishback Creek has a much larger catchment area than School Branch, and more rainfall occurred prior to the Fishback Creek sampling event. It should be noted that the discharge measured at the Zionsville USGS gauging station was approximately five times higher on 6/11/2004 than on 6/16/2004 and 6/17/2004. It could also be the case that less rainfall actually fell in the catchment area of the Zionsville gauging station than was measured at the Eagle Creek Airport. In which case, the estimated instantaneous discharge would be a biased low. However, the difference between the measured and estimated discharge at FC 7 was –0.14 m^3/s on 6/17/2004, indicating that under estimation is not likely occurring. As a result, these observations indicate that rainfall amount may not be directly correlated to discharge. For all compared measures, the actual measurements only varied from the estimated instantaneous discharge by as much as 0.39 m^3/s, which is acceptable when considering all of the factors that influence a discharge measurement. Furthermore, the necessity of an area correction factor suggests that catchment area effects the magnitude of discharge at all points along a stream, and that this influence is independent of the influence of land use and the amount of rainfall associated with a discharge event.

Appendix B. Indiana University-Purdue University Indianapolis Field Data, IUPUI Water Quality Analysis Data, and Veolia Labs, Indianapolis LCC Water Quality Analysis Data

Indiana University-Purdue University Indianapolis Field Data and Water Quality Analysis Data

Station ID	Date	Sample ID	Sample Time	Stage (m)	T (°C)	Cond (ms/cm)	SpC (us/cm)	TDS (g/L)	Sal (ppt)	DO (mg/L)	pH	Q (m3/s)	PO_4 (mg/L)	TSS (mg/L)
Wet season 2004 base flow														
Duplicate	5/12/2004	no id	1000	2.35	19.51	0.698	625	0.453	0.34	8.16	n/s	0.03		n/a
FC 1	5/12/2004	0504-333	1300	4.12	22.01	0.747	705	0.486	0.37	8.64	n/s	0.08	0.012	n/a
FC 2	5/12/2004	0504-332	1235	3.54	22.27	0.740	701	0.481	0.36	10.03	n/s	0.08	0.015	n/a
FC 3	5/12/2004	0504-331	1216	5.84	22.33	0.712	675	0.462	0.35	9.17	n/s	0.09	0.023	n/a
FC 4	5/12/2004	0504-330	1152	4.25	21.27	0.680	632	0.442	0.33	7.34	n/s	0.06	0.018	n/a
FC 5	5/12/2004	0504-329	1130	3.53	22.55	0.647	617	0.420	0.31	10.37	n/s	0.08	0.017	n/a
FC 6	5/12/2004	0504-328	1105	3.43	19.25	0.676	602	0.439	0.33	7.36	n/s	0.07	0.040	n/a
FC 7	5/12/2004	0504-327	1035	3.34	19.43	0.642	574	0.417	0.31	7.67	n/s	0.05	0.041	n/a
FC 8	5/12/2004	0504-326	1000	2.35	19.51	0.698	625	0.453	0.34	8.16	n/s	0.03	0.046	n/a
Duplicate	6/9/2004	0604-342	1250	7.18	22.94	0.637	611	0.414	0.31	8.71	8.10	0.07	0.038	n/a
SB 1	6/9/2004	0604-341	1250	7.18	22.94	0.637	611	0.414	0.31	8.71	8.10	0.07	0.038	n/a
SB 2	6/9/2004	0604-340	1215	5.40	23.46	0.635	616	0.413	0.31	10.95	8.04	0.06	0.035	n/a
SB 3	6/9/2004	0604-339	1155	2.40	21.51	0.636	595	0.414	0.31	9.68	7.93	0.04	0.041	n/a
SB 4	6/9/2004	0604-338	1140	1.57	22.08	0.677	639	0.440	0.33	10.90	7.81	0.04	0.038	n/a
SB 5	6/9/2004	0604-337	1115	3.01	20.16	0.646	589	0.420	0.32	9.29	7.58	0.04	0.047	n/a
SB 6	6/9/2004	0604-336	1050	3.69	19.88	0.667	603	0.433	0.32	8.77	7.52	0.02	0.044	n/a
SB 7	6/9/2004	0604-335	1005	3.34	21.17	0.667	618	0.434	0.32	4.36	7.46	0.00	0.056	n/a

Indiana University-Purdue University Indianapolis Field Data and Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Sample Time	Stage (m)	T (°C)	Cond (ms/cm)	SpC (us/cm)	TDS (g/L)	Sal (ppt)	DO (mg/L)	pH	Q (m3/s)	PO_4 (mg/L)	TSS (mg/L)
Wet season 2004 event flow														
Duplicate	6/11/2004	0604-353	1700	2.70	19.17	0.524	466	0.341	0.25	6.65	7.23	-	0.119	31.14
SB 1	6/11/2004	0604-357	1805	7.00	20.30	0.507	462	0.330	0.25	8.43	7.70	9.59	0.084	89.12
SB 1	6/11/2004	0604-349	1520	7.05	19.84	0.497	448	0.323	0.24	8.64	7.73	8.47	0.084	85.20
SB 2	6/11/2004	0604-356	1745	5.11	20.01	0.516	467	0.335	0.25	7.83	7.49	7.26	0.092	74.10
SB 2	6/11/2004	0604-348	1510	5.50	19.89	0.503	454	0.327	0.24	7.75	7.61	6.41	0.091	99.60
SB 3	6/11/2004	0604-355	1730	1.95	17.59	0.526	472	0.342	0.25	7.40	7.39	5.78	0.106	68.60
SB 3	6/11/2004	0604-347	1455	2.01	19.32	0.513	457	0.334	0.25	7.43	7.30	5.10	0.105	62.65
SB 4	6/11/2004	0604-354	1720	1.20	19.36	0.525	468	0.341	0.25	6.96	7.19	5.25	0.112	41.69
SB 4	6/11/2004	0604-346	1440	1.19	19.05	0.513	455	0.333	0.25	7.03	7.26	4.44	0.091	56.40
SB 5	6/11/2004	0604-352	1700	2.70	19.17	0.524	466	0.341	0.25	6.65	7.23	4.23	0.123	39.30
SB 5	6/11/2004	0604-345	1420	2.67	18.90	0.519	458	0.337	0.25	6.50	7.28	3.43	0.090	56.28
SB 6	6/11/2004	0604-351	1645	2.85	19.15	0.560	497	0.364	0.27	5.96	7.10	3.29	0.101	25.13
SB 6	6/11/2004	0604-344	1400	2.49	19.19	0.549	489	0.357	0.27	6.17	7.19	1.42	0.090	35.02
SB 7	6/11/2004	0604-350	1625	2.35	19.94	0.527	476	0.342	0.26	5.83	7.13	1.79	0.058	32.84
SB 7	6/11/2004	0604-343	1320	3.10	19.68	0.579	467	0.338	0.25	6.38	7.63	1.31	0.025	138.49
Duplicate	6/16/2004	0604-366	1315	3.49	21.34	0.394	366	0.256	0.19	7.97	7.79	-	0.100	221.28
FC 1	6/16/2004	0604-365	1315	3.49	21.34	0.394	366	0.256	0.19	7.97	7.79	4.93	0.087	227.27
FC 2	6/16/2004	0604-364	1305	3.19	21.28	0.391	363	0.254	0.19	8.02	7.76	4.78	0.086	229.61
FC 3	6/16/2004	0604-363	1245	5.13	20.85	0.405	373	0.263	0.19	7.95	7.71	4.05	0.105	167.54
FC 4	6/16/2004	0604-362	1230	3.87	20.59	0.434	398	0.283	0.21	7.87	7.69	3.53	0.093	85.13
FC 5	6/16/2004	0604-361	1220	2.89	20.14	0.434	393	0.282	0.21	7.71	7.64	2.91	0.118	77.37
FC 6	6/16/2004	0604-360	1150	3.03	19.39	0.443	396	0.288	0.21	7.71	7.51	2.14	0.130	123.96
FC 7	6/16/2004	0604-359	1130	2.83	19.09	0.443	393	0.288	0.21	7.21	7.31	1.51	0.126	54.13
FC 8	6/16/2004	0604-358	1050	1.80	18.59	0.483	424	0.314	0.23	6.62	7.45	0.72	0.096	28.98
Duplicate	6/17/2004	0604-374	1130	5.37	21.61	0.495	0	0.322	0.24	9.27	7.81	-	0.101	45.22
FC 1	6/17/2004	0604-376	1200	3.72	21.92	0.498	0	0.324	0.24	9.34	7.87	3.49	0.087	57.03
FC 2	6/17/2004	0604-375	1150	4.19	21.81	0.497	0	0.323	0.24	9.34	7.87	3.55	0.120	58.40

Indiana University-Purdue University Indianapolis Field Data and Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Sample Time	Stage (m)	T (°C)	Cond (ms/cm)	SpC (us/cm)	TDS (g/L)	Sal (ppt)	DO (mg/L)	pH	Q (m3/s)	PO_4 (mg/L)	TSS (mg/L)
FC 3	6/17/2004	0604-373	1130	5.37	21.61	0.495	0	0.322	0.24	9.27	7.81	3.16	0.107	43.37
FC 4	6/17/2004	0604-372	1115	3.97	21.16	0.503	0	0.327	0.24	9.16	7.82	2.82	0.104	42.02
FC 5	6/17/2004	0604-371	1100	3.07	20.89	0.511	0	0.332	0.25	9.14	7.77	2.42	0.101	37.18
FC 6	6/17/2004	0604-370	1018	3.19	19.54	0.526	0	0.342	0.25	8.84	7.60	1.96	0.105	18.31
FC 7	6/17/2004	0604-369	1002	3.02	19.29	0.529	0	0.344	0.26	8.32	7.51	1.45	0.105	15.32
FC 8	6/17/2004	0604-368	925	1.79	18.96	0.537	0	0.347	0.26	7.70	7.44	0.85	0.078	12.60
Dry season 2004 base flow														
Duplicate	9/9/2004	0409-109	1345	4.27	20.61	0.732	671	0.476	0.36	5.42	7.88	0.01	0.017	n/a
FC 1	9/9/2004	0409-108	1345	4.27	20.61	0.732	671	0.476	0.36	5.42	7.88	0.01	0.018	n/a
FC 2	9/9/2004	0409-107	1300	4.68	19.97	0.732	662	0.476	0.36	5.39	7.67	0.00	0.020	n/a
FC 3	9/9/2004	0409-106	1200	5.94	21.42	0.663	618	0.431	0.32	6.42	7.88	0.00	0.047	n/a
FC 4	9/9/2004	0409-105	1140	4.42	20.88	0.699	644	0.455	0.34	4.32	7.79	-0.05	0.050	n/a
FC 5	9/9/2004	0409-104	1100	3.61	18.71	0.561	494	0.364	0.27	5.14	7.95	-0.07	0.078	n/a
FC 6	9/9/2004	0409-103	1030	3.58	17.53	0.551	472	0.358	0.27	4.76	8.00	0.01	0.127	n/a
FC 7	9/9/2004	0409-102	950	3.34	16.76	0.818	689	0.532	0.4	4.70	7.64	0.00	0.006	n/a
FC 8	9/9/2004	0409-101	915	2.48	16.97	0.705	597	0.457	0.35	1.46	7.65	0.00	0.148	n/a
Duplicate	9/15/2004	0409-307	1330	7.35	20.46	0.714	652	0.464	0.35	9.28	8.02	0.01	0.031	n/a
SB 1	9/15/2004	0409-306	1330	7.35	20.46	0.714	652	0.464	0.35	9.28	8.02	0.01	0.038	n/a
SB 2	9/15/2004	0409-305	1310	5.53	20.77	0.806	740	0.523	0.4	8.55	7.72	0.00	0.018	n/a
SB 3	9/15/2004	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	-	-
SB 4	9/15/2004	0409-304	1240	1.75	23.84	0.683	668	0.444	0.33	1.32	7.44	0.00	0.172	n/a
SB 5	9/15/2004	0409-303	1220	2.65	27.44	0.741	776	0.481	0.36	13.32	8.37	0.00	0.221	n/a
SB 6	9/15/2004	0409-302	1150	2.74	20.57	0.688	30	0.447	0.34	4.85	7.69	0.00	0.160	n/a
SB 7	9/15/2004	0409-301	1045	3.54	20.36	0.572	521	0.372	0.28	5.31	7.54	-0.01	0.035	n/a

Indiana University-Purdue University Indianapolis Field Data and Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Sample Time	Stage (m)	T (°C)	Cond (ms/cm)	SpC (us/cm)	TDS (g/L)	Sal (ppt)	DO (mg/L)	pH	Q (m3/s)	PO_4 (mg/L)	TSS (mg/L)
Outfall	10/13/2004	0410-305	1150	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	0.00	0.065	20.72
SB 1	10/13/2004	0410-306	1248	7.32	12.91	0.629	0	0.409	0.31	13.24	7.74	0.01	0.024	13.20
SB 2	10/13/2004	0410-304	1150	5.74	15.37	0.540	0	0.357	0.26	10.93	7.47	0.01	0.037	11.63
SB 3	10/13/2004	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	-	-
SB 4	10/13/2004	0410-303	1100	1.74	12.44	1.316	1	N/S	0.66	0.78	7.89	0.00	0.687	26.63
SB 5	10/13/2004	0410-302	1047	3.17	13.70	0.914	1	N/S	0.26	12.21	7.90	0.00	0.196	72.32
SB 6	10/13/2004	0410-301	1011	N/S	12.77	0.623	0	N/S	0.3	0.16	7.58	0.00	0.173	19.03
SB 7	10/13/2004	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	-	-
Dry season 2004 event flow														
FC 1	10/15/2004	0410-317	1323	4.16	11..33	0.810	1	0.053	0.4	12.50	7.93	0.21	0.034	7.08
FC 2	10/15/2004	0410-316	1304	4.62	11.42	0.716	1	0.465	0.35	13.12	7.90	0.24	0.055	12.89
FC 3	10/15/2004	0410-315	1243	5.84	11.62	0.471	0	0.306	0.23	12.77	7.86	0.06	0.072	10.27
FC 4	10/15/2004	0410-314	1221	4.10	12.88	0.444	0	0.289	0.22	12.23	7.98	0.07	0.034	25.43
FC 5	10/15/2004	0410-313	1203	3.63	11.84	0.620	0	0.403	0.3	12.38	7.90	0.00	0.084	6.84
FC 6	10/15/2004	0410-312	1052	N/A	11.54	0.522	0	0.340	0.25	6.76	7.78	0.00	0.077	22.11
FC 7	10/15/2004	0410-311	1023	3.40	11.61	0.495	0	0.321	0.24	9.82	7.68	0.00	0.036	43.18
FC 8	10/15/2004	0410-310	1000	N/A	10.88	0.470	0	0.305	0.23	9.07	7.58	0.00	0.129	58.14
FC 1	11/2/2004	0411-307	1430	4.40	14.15	0.696	1	0.452	0.34	14.27	7.68	0.22	0.058	6.95
FC 2	11/2/2004	0411-306	1410	4.51	14.29	0.677	1	0.440	0.33	14.05	7.69	0.26	0.054	5.68
FC 3	11/2/2004	0411-305	1340	5.78	14.20	0.646	1	0.420	0.32	12.81	7.72	0.16	0.068	51.92
FC 4	11/2/2004	0411-304	1315	4.10	14.75	0.718	1	0.467	0.35	10.63	7.67	0.11	0.042	8.70
FC 5	11/2/2004	0411-303	1255	3.43	14.41	0.586	0	0.381	0.29	7.25	7.56	0.14	0.202	15.52
FC 6	11/2/2004	0411-302	1205	3.42	14.22	0.589	0	0.383	0.29	8.40	7.57	0.05	0.185	4.85
FC 7	11/2/2004	0411-301	1115	3.30	14.28	0.347	0	0.226	0.17	3.83	7.40	0.06	0.275	14.24
FC 8	11/2/2004	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	-	-

Indiana University-Purdue University Indianapolis Field Data and Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Sample Time	Stage (m)	T (°C)	Cond (ms/cm)	SpC (us/cm)	TDS (g/L)	Sal (ppt)	DO (mg/L)	pH	Q (m3/s)	PO_4 (mg/L)	TSS (mg/L)
Field Blank	11/2/2004	0411-300	700	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	0.002	-0.20
SB 1	11/2/2004	0411-313	1730	7.10	14.28	0.457	0	0.297	0.22	15.65	7.70	0.41	0.075	14.35
SB 2	11/2/2004	0411-312	1705	5.22	14.15	0.516	0	0.336	0.25	14.15	7.49	0.24	0.078	19.47
SB 3	11/2/2004	0411-311	1640	2.11	14.05	0.526	0	0.407	0.31	12.3	7.58	0.10	0.116	23.25
SB 4	11/2/2004	0411-310	1620	1.53	13.84	0.587	0	0.381	0.29	10.85	7.54	0.07	0.127	9.18
SB 5	11/2/2004	0411-309	1605	2.50	13.56	0.490	0	0.357	0.27	12.34	7.28	0.05	0.101	12.47
SB 6	11/2/2004	0411-308	1540	2.67	13.72	0.532	0	0.346	0.26	15.19	7.15	0.36	0.068	16.84
SB 7	11/2/2004	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S		
Wet season 2005 base flow														
Duplicate	3/21/2005	0503-312	1600	3.95	10.17	0.529	0	0.344	0.26	n/s	8.58	0.00	0.002	N/A
FC 1	3/21/2005	0503-309	1455	4.15	7.20	0.701	0	0.456	0.34	n/s	8.16	0.17	0.000	N/A
FC 2	3/21/2005	0503-308	1425	4.64	7.45	0.696	0	0.452	0.34	n/s	8.12	0.21	0.000	N/A
FC 3	3/21/2005	0503-307	1405	5.93	7.43	0.672	0	0.436	0.33	n/s	8.28	0.42		N/A
FC 4	3/21/2005	0503-306	1315	4.38	7.08	0.646	0	0.420	0.32	n/s	8.11	0.11	0.000	N/A
FC 5	3/21/2005	0503-305	1305	3.62	7.08	0.637	0	0.414	0.31	n/s	8.03	0.14	0.001	N/A
FC 6	3/21/2005	0503-304	1130	3.57	4.08	0.637	0	0.414	0.31	n/s	8.17	0.09	0.001	N/A
FC 7	3/21/2005	0503-303	1100	3.45	3.81	0.635	0	0.411	0.31	n/s	8.35	0.06	0.000	N/A
FC 8	3/21/2005	0503-302	940	2.43	3.84	0.689	0	0.447	0.33	n/s	8.44	0.02	0.000	N/A
SB 1	3/21/2005	0503-317	1800	7.35	7.69	0.542	0	0.352	0.26	n/s	7.46	0.05	0.001	N/A
SB 2	3/21/2005	0503-316	1740	5.50	9.23	0.565	0	0.367	0.27	n/s	7.26	0.06	0.002	N/A
SB 3	3/21/2005	0503-315	1705	2.3	8.6	0.453	0	0.295	0.22	n/s	8.39	0.04	0.001	N/A
SB 4	3/21/2005	0503-314	1640	1.65	10.81	0.543	0	0.353	0.26	n/s	8.46	0.02	0.003	N/A
SB 5	3/21/2005	0503-313	1620	2.60	10.43	0.557	0	0.362	0.24	n/s	8.45	0.02	0.003	N/A
SB 6	3/21/2005	0503-311	1600	3.95	10.17	0.529	0	0.344	0.26	n/s	8.58	0.00	0.004	N/A
SB 7	3/21/2005	0503-310	1520	3.40	9.35	0.562	0	0.365	0.27	n/s	8.46	0.00	0.002	N/A

Indiana University-Purdue University Indianapolis Field Data and Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Sample Time	Stage (m)	T (°C)	Cond (ms/cm)	SpC (us/cm)	TDS (g/L)	Sal (ppt)	DO (mg/L)	pH	Q (m3/s)	PO_4 (mg/L)	TSS (mg/L)
Wet season 2005 event flow														
Duplicate	4/22/2005	0504-318	1600	7.60	14.56	0.445	0	0.789	0.22	9.64	7.80	n/a	0.108	
FC 1	4/22/2005	0504-309	1315	3.70	14.65	0.593	0	0.385	0.29	9.91	8.02	4.59	0.001	0.38
FC 2	4/22/2005	0504-308	1300	4.10	14.69	0.593	0	0.385	0.29	9.47	8.02	4.53	0.001	0.78
FC 3	4/22/2005	0504-307	1230	5.28	14.11	0.553	0	0.359	0.27	9.68	7.99	3.96	0.001	0.31
FC 4	4/22/2005	0504-306	1145	3.84	13.44	0.464	0	0.302	0.22	9.69	7.22	3.52	0.027	0.24
FC 5	4/22/2005	0504-305	1130	2.85	12.25	0.402	0	0.261	0.19	10.29	7.47	2.96	0.120	0.36
FC 6	4/22/2005	0504-304	1035	3.50	11.26	0.389	0	0.253	0.19	10.04	7.66	2.36	0.141	0.29
FC 7	4/22/2005	0504-303	1000	2.85	11.46	0.392	0	0.255	0.19	9.87	7.15	1.71	0.114	0.19
FC 8	4/22/2005	0504-302	930	1.36	11.11	0.359	0	0.233	0.17	8.97	7.83	0.95	0.105	0.10
Field Blank	4/22/2005	0504-301	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.000	0.00
SB 7	4/22/2005	0504-310	1345	3.00	13.10	0.471	0	0.306	0.23	8.33	7.35	0.37	0.190	0.03
SB 1	4/22/2005	0504-317	1600	7.60	14.56	0.445	0	0.789	0.22	9.64	7.80	1.85	0.110	0.12
SB 2	4/22/2005	0504-316	1520	5.00	14.98	0.450	0	0.293	0.22	9.10	7.68	1.41	0.130	0.11
SB 3	4/22/2005	0504-315	1500	1.95	14.41	0.487	0	0.316	0.24	8.71	7.53	1.13	0.110	0.11
SB 4	4/22/2005	0504-313	1445	1.03	13.87	0.509	0	0.331	0.25	0.91	7.53	1.04	0.113	0.08
SB 5	4/22/2005	0504-312	1430	2.66	13.74	0.493	0	0.320	0.24	8.96	7.48	0.85	0.132	0.07
SB 6	4/22/2005	0504-311	1415	2.45	12.70	0.433	0	0.281	0.21	8.10	7.37	0.66	0.122	0.07

*Note: Indiana University-Purdue University Indianapolis Field Data and Water Quality Analysis Data tables contain the following abbreviations in column headings: temperature (T), conductance (Cond), and specific conductance (SpC), total dissolved solids (TDS), salinity (Sal), dissolved oxygen (DO), discharge (Q), phosphate (PO_4), total suspended solids (TSS).

Veolia Labs, Indianapolis LCC Water Quality Analysis Data

Station ID	Date	Sample ID	Time	Alkalinity (mg/L)	pH	Turbidity (NTU)	Dissolved Silica (mg/L)	Total Silica (mg/L)	Total Suspended Solids (g/mL)	Flouride (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Nitrite (mg/L)
Wet season 2004 base flow													
Duplicate	5/12/2004	no id	1000	270	8.02	4.9	8.06	8.06	5.6	0.240	36.8	31.9	<0.100
FC 1	5/12/2004	0504-333	1300	264	8.07	8.9	7.59	7.82	14.0	0.230	53.9	37.4	<0.100
FC 2	5/12/2004	0504-332	1235	262	8.18	3.4	8.06	8.06	2.8	0.230	53.3	37.3	<0.100
FC 3	5/12/2004	0504-331	1216	252	8.09	3.1	8.30	8.30	6.4	0.230	49.7	37.1	<0.100
FC 4	5/12/2004	0504-330	1152	250	7.94	3.3	8.30	7.82	3.2	0.230	41.0	37.5	<0.100
FC 5	5/12/2004	0504-329	1130	250	8.13	2.4	9.31	9.57	3.6	0.230	33.4	35.9	<0.100
FC 6	5/12/2004	0504-328	1105	266	7.97	2.2	11.94	11.94	1.2	0.260	31.4	37.1	0.100
FC 7	5/12/2004	0504-327	1035	246	7.88	2.5	11.62	11.62	2.0	0.240	34.3	34.0	<0.100
FC 8	5/12/2004	0504-326	1000	276	7.94	5.1	8.06	8.06	5.6	0.220	37.4	31.8	<0.100
Duplicate	6/9/2004	0604-342	1250	234	8.39	4.3	8.06	8.54	4.4	0.23	30.1	33.5	<0.100
SB 1	6/9/2004	0604-341	1250	234	8.39	4.2	7.82	8.06	4.4	0.22	30.1	33.6	<0.100
SB 2	6/9/2004	0604-340	1215	236	8.35	3.5	7.82	8.06	3.6	0.22	27.7	30.0	<0.100
SB 3	6/9/2004	0604-339	1155	232	8.18	4.2	8.30	8.54	4.8	0.18	26.5	24.8	<0.100
SB 4	6/9/2004	0604-338	1140	240	8.08	4.5	9.05	9.31	5.6	0.17	37.0	25.1	<0.100
SB 5	6/9/2004	0604-337	1115	242	7.80	4.3	9.31	9.57	5.2	0.16	25.4	23.4	<0.100
SB 6	6/9/2004	0604-336	1050	246	7.86	8.6	10.12	10.12	14.0	0.20	29.7	23.9	<0.100
SB 7	6/9/2004	0604-335	1005	262	7.58	11.0	11.00	11.00	16.4	0.19	33.8	22.3	0.129

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Nitrate (mg/L)	Phosphate (mg/L)	Ammonia (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Total Hardness (mg/L)	Dissolved Copper (mg/L)	Dissolved Iron (mg/L)
Wet season 2004 base flow													
Duplicate	5/12/2004	no id	1000	1.910	<0.100	0.1850	90.90	29.40	1.18	13.70	348	<0.020	0.0700
FC 1	5/12/2004	0504-333	1300	<0.500	<0.100	0.1700	86.40	29.40	1.98	31.00	337	<0.020	0.0800
FC 2	5/12/2004	0504-332	1235	<0.500	<0.100	0.1450	84.80	28.90	2.00	30.70	331	<0.020	0.1000
FC 3	5/12/2004	0504-331	1216	<0.500	<0.100	0.1920	81.90	28.70	1.99	26.90	323	<0.020	0.0900
FC 4	5/12/2004	0504-330	1152	0.548	<0.100	0.1750	80.70	28.60	2.14	20.10	319	<0.020	0.0900
FC 5	5/12/2004	0504-329	1130	1.000	<0.100	0.1110	79.90	28.50	2.23	14.80	317	<0.020	0.0800
FC 6	5/12/2004	0504-328	1105	1.960	<0.100	0.1780	88.10	29.30	1.50	12.70	340	<0.020	0.0600
FC 7	5/12/2004	0504-327	1035	2.240	<0.100	0.1270	79.60	28.40	1.29	13.10	316	<0.020	0.0800
FC 8	5/12/2004	0504-326	1000	1.900	<0.100	0.2360	90.60	29.40	1.55	14.01	347	<0.020	0.0700
Duplicate	6/9/2004	0604-342	1250	5.510	<0.100	0.176	89.00	26.00	1.81	12.60	329	<0.020	0.0400
SB 1	6/9/2004	0604-341	1250	5.420	<0.100	0.152	89.00	26.00	1.92	12.70	329	<0.020	0.0400
SB 2	6/9/2004	0604-340	1215	6.720	<0.100	0.152	91.00	26.40	1.59	9.61	336	<0.020	0.0400
SB 3	6/9/2004	0604-339	1155	8.290	<0.100	<0.100	91.60	26.00	1.38	8.49	336	<0.020	<.02
SB 4	6/9/2004	0604-338	1140	8.350	<0.100	<0.100	92.40	26.20	1.41	15.90	338	<0.020	0.0300
SB 5	6/9/2004	0604-337	1115	8.930	<0.100	<0.100	92.90	26.00	1.33	8.75	339	<0.020	0.0400
SB 6	6/9/2004	0604-336	1050	9.280	<0.100	<0.100	94.20	26.80	1.30	10.10	345	<0.020	0.0300
SB 7	6/9/2004	0604-335	1005	4.170	<0.100	0.344	93.30	26.60	1.62	12.90	342	<0.020	0.0300

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Manganese (mg/L)	Total P (mg/L)	TKN (mg/L)	TOC (mg/L)	DOC (mg/L)	Total Coliform (colonies per 100 mL)	E. Coli (colonies per 100 mL)	Heterotrophic Plate Count (colonies per 100 mL)	Atrazine (ug/L)	Bromide (mg/L)
Wet season 2004 base flow													
Duplicate	5/12/2004	no id	1000	0.080	0.093	1.45	3.39	3.43	N/S	N/S	N/S	N/S	N/S
FC 1	5/12/2004	0504-333	1300	0.030	0.054	0.73	3.91	3.85	N/S	N/S	N/S	N/S	N/S
FC 2	5/12/2004	0504-332	1235	0.020	0.041	0.68	3.99	3.93	N/S	N/S	N/S	N/S	N/S
FC 3	5/12/2004	0504-331	1216	0.040	0.064	0.93	4.02	3.99	N/S	N/S	N/S	N/S	N/S
FC 4	5/12/2004	0504-330	1152	0.060	0.064	1.03	4.24	4.08	N/S	N/S	N/S	N/S	N/S
FC 5	5/12/2004	0504-329	1130	0.030	0.074	1.09	4.08	4.01	N/S	N/S	N/S	N/S	N/S
FC 6	5/12/2004	0504-328	1105	0.030	0.082	1.01	3.53	3.36	N/S	N/S	N/S	N/S	N/S
FC 7	5/12/2004	0504-327	1035	0.030	0.075	1.02	3.46	3.50	N/S	N/S	N/S	N/S	N/S
FC 8	5/12/2004	0504-326	1000	0.090	0.093	1.68	4.37	4.15	N/S	N/S	N/S	N/S	N/S
Duplicate	6/9/2004	0604-342	1250	<0.020	0.060	0.86	2.63	2.57	N/S	N/S	N/S	N/S	N/S
SB 1	6/9/2004	0604-341	1250	<0.020	0.056	0.96	3.00	2.94	N/S	N/S	N/S	N/S	N/S
SB 2	6/9/2004	0604-340	1215	<0.020	0.257	0.88	2.92	2.62	N/S	N/S	N/S	N/S	N/S
SB 3	6/9/2004	0604-339	1155	<0.020	0.382	0.97	2.34	2.17	N/S	N/S	N/S	N/S	N/S
SB 4	6/9/2004	0604-338	1140	<0.020	0.056	0.97	2.22	1.94	N/S	N/S	N/S	N/S	N/S
SB 5	6/9/2004	0604-337	1115	<0.020	0.058	1.06	1.95	1.83	N/S	N/S	N/S	N/S	N/S
SB 6	6/9/2004	0604-336	1050	0.030	0.081	0.94	2.48	2.29	N/S	N/S	N/S	N/S	N/S
SB 7	6/9/2004	0604-335	1005	0.100	0.126	1.36	3.91	2.99	N/S	N/S	N/S	N/S	N/S

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Alkalinity (mg/L)	pH	Turbidity (NTU)	Dissolved Silica (mg/L)	Total Silica (mg/L)	Total Suspended Solids (g/mL)	Flouride (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Nitrite (mg/L)
Wet season 2004 event flow													
Duplicate	6/11/2004	0604-353	1700	152	7.24	30.0	10.41	11.00	22.0	0.15	16.0	16.9	0.341
SB 1	6/11/2004	0604-357	1805	152	7.95	71.0	9.57	10.12	92.4	0.16	16.8	17.4	0.533
SB 1	6/11/2004	0604-349	1520	152	7.86	61.0	9.31	9.84	71.6	0.16	16.8	18.1	0.443
SB 2	6/11/2004	0604-356	1745	152	7.59	45.0	9.84	10.41	68.8	0.15	17.4	17.9	0.364
SB 2	6/11/2004	0604-348	1510	150	7.51	59.0	9.57	10.12	99.6	0.16	16.5	16.8	0.547
SB 3	6/11/2004	0604-355	1730	154	7.44	48.0	10.12	10.70	60.4	0.16	17.6	17.9	0.381
SB 3	6/11/2004	0604-347	1455	150	7.40	45.0	10.12	10.12	59.2	0.15	16.1	16.4	0.532
SB 4	6/11/2004	0604-354	1720	152	7.35	29.0	10.41	11.00	29.2	0.15	16.9	16.9	0.365
SB 4	6/11/2004	0604-346	1440	150	7.28	37.0	10.12	10.41	56.0	0.15	15.7	16.0	0.526
SB 5	6/11/2004	0604-352	1700	154	7.25	28.0	10.41	11.00	30.0	0.15	16.5	17.6	0.339
SB 5	6/11/2004	0604-345	1420	150	7.14	37.0	10.12	10.40	49.2	0.15	15.8	16.4	0.486
SB 6	6/11/2004	0604-351	1645	158	7.17	24.0	10.70	11.00	24.4	0.15	18.7	17.9	0.419
SB 6	6/11/2004	0604-344	1400	150	7.06	45.0	10.41	10.70	29.2	0.15	18.5	16.8	0.562
SB 7	6/11/2004	0604-350	1625	180	7.23	36.0	10.70	11.00	16.8	0.17	22.5	16.9	<0.100
SB 7	6/11/2004	0604-343	1320	176	7.05	100.0	10.41	10.70	147.0	0.17	22.5	16.6	0.116
Duplicate	6/16/2004	0604-366	1315	138	7.80	130.0	8.30	8.30	225.0	0.140	24.0	15.8	<0.200
FC 1	6/16/2004	0604-365	1315	136	7.79	140.0	8.06	8.79	229.0	0.180	24.3	16.2	<0.200
FC 2	6/16/2004	0604-364	1305	134	7.80	160.0	8.79	9.05	257.0	0.150	24.6	16.6	<0.200
FC 3	6/16/2004	0604-363	1245	142	7.77	92.0	8.30	8.79	169.0	0.170	24.7	16.2	<0.200
FC 4	6/16/2004	0604-362	1230	148	7.77	44.0	9.31	9.31	82.8	0.170	25.1	18.1	<0.200
FC 5	6/16/2004	0604-361	1220	150	7.70	59.0	9.05	9.57	90.8	0.170	21.1	17.8	<0.200
FC 6	6/16/2004	0604-360	1150	156	7.53	54.0	9.05	9.31	126.0	0.180	18.7	19.6	<0.200
FC 7	6/16/2004	0604-359	1130	154	7.42	46.0	9.31	9.57	58.8	0.170	18.0	19.0	<0.200
FC 8	6/16/2004	0604-358	1050	168	7.24	23.0	9.57	10.12	26.8	0.210	21.1	18.9	<0.200

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Nitrate (mg/L)	Phosphate (mg/L)	Ammonia (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Total Hardness (mg/L)	Dissolved Copper (mg/L)	Dissolved Iron (mg/L)
Wet season 2004 event flow													
Duplicate	6/11/2004	0604-353	1700	16.500	<0.100	0.383	70.30	18.10	3.29	5.59	250	<0.020	0.0210
SB 1	6/11/2004	0604-357	1805	14.600	<0.100	0.510	67.80	17.40	3.14	6.23	241	<0.020	0.0290
SB 1	6/11/2004	0604-349	1520	13.600	<0.100	0.386	66.90	17.30	3.15	6.28	238	<0.020	0.0240
SB 2	6/11/2004	0604-356	1745	14.600	<0.100	0.429	69.30	17.90	3.07	5.98	247	<0.020	0.0290
SB 2	6/11/2004	0604-348	1510	15.100	<0.100	0.576	66.80	17.20	3.10	6.11	238	<0.020	0.0200
SB 3	6/11/2004	0604-355	1730	16.100	<0.100	0.452	70.70	18.30	3.23	6.29	252	<0.020	0.0260
SB 3	6/11/2004	0604-347	1455	16.400	<0.100	0.601	68.00	17.60	3.09	5.66	242	<0.020	0.0210
SB 4	6/11/2004	0604-354	1720	16.200	<0.100	0.399	69.90	18.00	3.17	5.88	249	<0.020	0.0250
SB 4	6/11/2004	0604-346	1440	16.600	<0.100	0.530	68.30	17.60	3.17	5.57	243	<0.020	0.0260
SB 5	6/11/2004	0604-352	1700	16.900	<0.100	0.368	70.00	18.00	3.42	5.66	249	<0.020	0.0240
SB 5	6/11/2004	0604-345	1420	16.900	<0.100	0.520	69.00	17.80	3.29	5.54	245	<0.020	0.0310
SB 6	6/11/2004	0604-351	1645	18.800	<0.100	0.463	74.80	19.20	3.35	6.74	266	<0.020	0.0220
SB 6	6/11/2004	0604-344	1400	19.400	<0.100	0.608	72.00	18.50	3.47	6.46	256	<0.020	0.0210
SB 7	6/11/2004	0604-350	1625	8.980	<0.100	0.158	70.50	19.10	1.96	9.71	255	<0.020	0.0250
SB 7	6/11/2004	0604-343	1320	9.910	<0.100	0.234	69.20	18.80	2.77	8.87	250	<0.020	0.0260
Duplicate	6/16/2004	0604-366	1315	2.560	<0.200	0.0760	50.60	13.70	3.67	15.40	183	<0.020	0.0490
FC 1	6/16/2004	0604-365	1315	2.480	<0.200	0.0450	51.40	14.00	3.71	15.40	186	<0.020	0.0400
FC 2	6/16/2004	0604-364	1305	2.620	<0.200	0.0660	50.50	13.60	3.60	14.90	182	<0.020	0.0400
FC 3	6/16/2004	0604-363	1245	3.150	0.140	0.0760	51.80	13.80	3.56	15.20	186	<0.020	0.0360
FC 4	6/16/2004	0604-362	1230	3.990	<0.200	0.0610	55.90	15.10	3.18	15.30	202	<0.020	0.0440
FC 5	6/16/2004	0604-361	1220	4.600	<0.200	0.0760	59.20	16.50	3.36	11.00	216	<0.020	0.0450
FC 6	6/16/2004	0604-360	1150	6.230	<0.200	0.0860	63.00	17.30	3.14	7.99	228	<0.020	0.0350
FC 7	6/16/2004	0604-359	1130	6.770	<0.200	0.1190	61.10	16.90	3.06	6.53	222	<0.020	0.0330
FC 8	6/16/2004	0604-358	1050	8.310	<0.200	0.0370	66.70	18.60	2.28	7.43	243	<0.020	0.0330

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Manganese (mg/L)	Total P (mg/L)	TKN (mg/L)	TOC (mg/L)	DOC (mg/L)	Total Coliform (colonies per 100 mL)	E. Coli (colonies per 100 mL)	Heterotrophic Plate Count (colonies per 100 mL)	Atrazine (ug/L)	Bromide (mg/L)
Wet season 2004 event flow													
Duplicate	6/11/2004	0604-353	1700	<0.020	0.223	1.86	6.12	6.09	n/a	n/a	n/a	N/S	N/S
SB 1	6/11/2004	0604-357	1805	<0.020	0.243	2.34	5.50	5.23	>24192	17329.00	3100.00	N/S	N/S
SB 1	6/11/2004	0604-349	1520	<0.020	0.264	2.02	5.59	5.22	>24192	19863.00	3600.00	N/S	N/S
SB 2	6/11/2004	0604-356	1745	<0.020	0.249	2.03	5.62	5.29	>24192	17329.00	3600.00	N/S	N/S
SB 2	6/11/2004	0604-348	1510	<0.020	0.271	2.32	5.65	5.34	>24192	>24192	4600.00	N/S	N/S
SB 3	6/11/2004	0604-355	1730	<0.020	0.258	2.27	6.01	5.56	>24192	11199.00	2100.00	N/S	N/S
SB 3	6/11/2004	0604-347	1455	<0.020	0.254	2.27	6.05	5.56	>24192	17329.00	4600.00	N/S	N/S
SB 4	6/11/2004	0604-354	1720	<0.020	0.230	1.85	6.14	5.66	>24192	14136.00	3600.00	N/S	N/S
SB 4	6/11/2004	0604-346	1440	<0.020	0.244	1.70	6.12	5.64	>24192	>24192	5600.00	N/S	N/S
SB 5	6/11/2004	0604-352	1700	<0.020	0.228	1.91	6.45	6.03	>24192	12997.00	5100.00	N/S	N/S
SB 5	6/11/2004	0604-345	1420	<0.020	0.261	2.17	6.17	5.78	>24192	>24192	6700.00	N/S	N/S
SB 6	6/11/2004	0604-351	1645	<0.020	0.208	2.27	6.23	5.72	>24192	12033.00	4100.00	N/S	N/S
SB 6	6/11/2004	0604-344	1400	<0.020	0.249	2.44	6.63	6.42	>24192	17329.00	5100.00	N/S	N/S
SB 7	6/11/2004	0604-350	1625	<0.020	0.175	1.55	6.02	5.57	>24192	24192.00	4100.00	N/S	N/S
SB 7	6/11/2004	0604-343	1320	<0.020	0.342	2.61	6.66	5.83	>24192	>24192	13000.00	N/S	N/S
Duplicate	6/16/2004	0604-366	1315	<0.020	0.490	1.68	7.07	7.37	N/S	N/S	N/S	N/S	N/S
FC 1	6/16/2004	0604-365	1315	<0.020	0.513	1.66	7.12	7.24	64880	1460	670000	N/S	N/S
FC 2	6/16/2004	0604-364	1305	<0.020	0.526	1.34	6.49	6.45	92080	1580	670000	N/S	N/S
FC 3	6/16/2004	0604-363	1245	<0.020	0.393	1.62	6.60	6.82	81640	1090	210000	N/S	N/S
FC 4	6/16/2004	0604-362	1230	<0.020	0.324	1.56	6.67	6.48	81640	1610	310000	N/S	N/S
FC 5	6/16/2004	0604-361	1220	<0.020	0.363	1.89	6.31	6.08	155310	1340	360000	N/S	N/S
FC 6	6/16/2004	0604-360	1150	<0.020	0.417	1.31	5.72	5.89	198630	960	510000	N/S	N/S
FC 7	6/16/2004	0604-359	1130	<0.020	0.316	1.16	5.84	5.79	120330	410	360000	N/S	N/S
FC 8	6/16/2004	0604-358	1050	<0.020	0.215	1.30	4.68	4.87	>241920	860	310000	N/S	N/S

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Alkalinity (mg/L)	pH	Turbidity (NTU)	Dissolved Silica (mg/L)	Total Silica (mg/L)	Total Suspended Solids (g/mL)	Flouride (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Nitrite (mg/L)
Wet season 2004 event flow													
Duplicate	6/17/2004	0604-374	1130	170	7.93	28.0	10.12	10.12	46.4	0.190	26.5	20.3	<0.200
FC 1	6/17/2004	0604-376	1200	170	7.97	27.0	9.57	10.12	55.2	0.180	27.8	21.0	<0.200
FC 2	6/17/2004	0604-375	1150	174	7.96	55.0	9.84	10.41	59.2	0.170	27.1	20.4	<0.200
FC 3	6/17/2004	0604-373	1130	172	7.93	50.0	9.84	10.12	44.4	0.210	25.9	20.5	<0.200
FC 4	6/17/2004	0604-372	1115	176	7.85	33.0	10.12	10.41	44.8	0.220	25.1	22.1	<0.200
FC 5	6/17/2004	0604-371	1100	184	7.78	36.0	10.12	10.12	37.6	0.230	22.6	22.4	<0.200
FC 6	6/17/2004	0604-370	1018	186	7.64	18.0	10.70	10.70	21.6	0.180	21.3	22.3	<0.200
FC 7	6/17/2004	0604-369	1002	190	7.51	12.0	11.00	10.70	16.0	0.190	21.4	21.2	<0.200
FC 8	6/17/2004	0604-368	925	188	7.52	9.6	10.41	10.70	14.4	0.160	22.9	20.2	<0.200

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Nitrate (mg/L)	Phosphate (mg/L)	Ammonia (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Total Hardness (mg/L)	Dissolved Copper (mg/L)	Dissolved Iron (mg/L)
Wet season 2004 event flow													
Duplicate	6/17/2004	0604-374	1130	4.790	<0.200	<0.0400	66.50	18.80	3.43	14.40	244	<0.020	0.0340
FC 1	6/17/2004	0604-376	1200	4.400	<0.200	<0.0400	65.60	18.40	3.29	14.70	240	<0.020	0.0350
FC 2	6/17/2004	0604-375	1150	4.420	<0.200	0.0500	65.50	18.50	3.30	15.00	240	0.020	0.0430
FC 3	6/17/2004	0604-373	1130	4.430	<0.200	0.0450	65.40	18.40	3.33	13.50	239	<0.020	0.0320
FC 4	6/17/2004	0604-372	1115	5.360	<0.200	<0.0400	68.30	19.30	3.34	12.60	250	<0.020	0.0310
FC 5	6/17/2004	0604-371	1100	6.210	<0.200	<0.0400	70.70	20.00	2.84	9.57	259	<0.020	0.0310
FC 6	6/17/2004	0604-370	1018	7.270	<0.200	<0.0400	74.00	20.60	2.67	8.41	270	<0.020	0.0320
FC 7	6/17/2004	0604-369	1002	8.020	<0.200	<0.0400	75.20	21.10	2.52	9.14	275	<0.020	0.0240
FC 8	6/17/2004	0604-368	925	8.590	<0.200	<0.0400	73.90	20.80	2.12	8.54	270	<0.020	0.0320

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Manganese (mg/L)	Total P (mg/L)	TKN (mg/L)	TOC (mg/L)	DOC (mg/L)	Total Coliform (colonies per 100 mL)	E. Coli (colonies per 100 mL)	Heterotrophic Plate Count (colonies per 100 mL)	Atrazine (ug/L)	Bromide (mg/L)
Wet season 2004 event flow													
Duplicate	6/17/2004	0604-374	1130	<0.020	0.222	1.67	6.38	6.33	N/S	N/S	N/S	N/S	N/S
FC 1	6/17/2004	0604-376	1200	<0.020	0.257	1.45	6.04	5.96	>241920	12110	100000	N/S	N/S
FC 2	6/17/2004	0604-375	1150	<0.020	0.253	1.17	5.96	5.83	>241920	13330	40000	N/S	N/S
FC 3	6/17/2004	0604-373	1130	<0.020	0.248	1.61	6.34	6.28	>241920	12420	34000	N/S	N/S
FC 4	6/17/2004	0604-372	1115	<0.020	0.252	1.10	6.60	6.61	>241920	21050	46000	N/S	N/S
FC 5	6/17/2004	0604-371	1100	<0.020	0.212	1.16	5.38	5.39	>241920	54750	40000	N/S	N/S
FC 6	6/17/2004	0604-370	1018	<0.020	0.189	1.27	5.24	5.27	>241920	22240	40000	N/S	N/S
FC 7	6/17/2004	0604-369	1002	<0.020	0.195	0.47	4.69	4.72	>241920	34480	51000	N/S	N/S
FC 8	6/17/2004	0604-368	925	<0.020	0.126	2.02	4.70	4.54	>241920	8550	40000	N/S	N/S

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Alkalinity (mg/L)	pH	Turbidity (NTU)	Dissolved Silica (mg/L)	Total Silica (mg/L)	Total Suspended Solids (g/mL)	Flouride (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Nitrite (mg/L)
Dry season 2004 base flow													
Duplicate	9/9/2004	0409-109	1345	230	8.02	5.3	6.71	6.71	5.6	0.338	72.18	30.04	0.200
FC 1	9/9/2004	0409-108	1345	228	8.05	5.7	6.50	6.93	6.0	0.317	72.38	30.41	0.200
FC 2	9/9/2004	0409-107	1300	244	7.78	3.6	7.37	7.59	4.0	0.327	65.95	27.06	0.200
FC 3	9/9/2004	0409-106	1200	214	7.99	3.6	6.93	6.93	7.2	0.397	59.5	26.14	0.200
FC 4	9/9/2004	0409-105	1140	224	7.90	4.1	4.94	4.94	6.0	0.267	72.49	20.9	0.200
FC 5	9/9/2004	0409-104	1100	232	8.07	3.8	6.30	6.30	3.2	0.23	30.77	16.18	0.200
FC 6	9/9/2004	0409-103	1030	230	8.08	3.9	7.14	7.39	5.6	0.309	23.36	28.47	0.200
FC 7	9/9/2004	0409-102	950	324	7.81	10.0	11.60	11.60	9.2	0.575	25.65	85.67	0.200
FC 8	9/9/2004	0409-101	915	294	7.75	110.0	11.90	11.90	58.0	0.444	55.41	16	0.200
Duplicate	9/15/2004	0409-307	1330	266	8.19	3.6	8.79	9.05	3.2	0.326	28.08	41.95	0.200
SB 1	9/15/2004	0409-306	1330	264	8.19	3.2	8.79	9.31	3.6	0.316	28.38	42.46	0.200
SB 2	9/15/2004	0409-305	1310	272	7.92	4.6	11.90	12.30	2.4	0.45	27.89	69.42	0.200
SB 3	9/15/2004	-	-	-	-	-	-	-	-	-	-	-	-
SB 4	9/15/2004	0409-304	1240	232	7.53	21.0	8.79	9.31	24.8	0.197	54.71	8.65	0.200
SB 5	9/15/2004	0409-303	1220	216	8.43	10.0	13.30	14.10	8.4	0.226	81.46	16	0.200
SB 6	9/15/2004	0409-302	1150	254	7.78	7.1	7.37	7.82	6.8	0.21	39.97	13.67	0.200
SB 7	9/15/2004	0409-301	1045	188	7.61	28.0	11.00	11.90	57.6	0.198	32	32.49	0.200
Outfall	10/13/2004	0410-305	1150	67	7.85	23.0	3.56	3.89	14.4	0.159	10.87	18.83	0.300
SB 1	10/13/2004	0410-306	1248	254	8.08	6.0	11.00	11.30	15.6	0.282	27.35	42.22	0.300
SB 2	10/13/2004	0410-304	1150	174	7.48	13.0	9.05	9.57	11.4	0.427	24.52	71.55	0.300
SB 3	10/13/2004	-	-	-	-	-	-	-	-	-	-	-	-
SB 4	10/13/2004	0410-303	1100	396	7.95	46.0	13.69	15.20	31.7	0.246	87.16	12.92	0.300
SB 5	10/13/2004	0410-302	1047	222	8.00	18.0	8.79	9.05	107.6	0.242	158.68	16.53	0.300
SB 6	10/13/2004	0410-301	1011	266	7.80	11.0	7.82	8.54	12.8	0.174	36.74	13.9	0.300
SB 7	10/13/2004	-	-	-	-	-	-	-	-	-	-	-	-

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Nitrate (mg/L)	Phosphate (mg/L)	Ammonia (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Total Hardness (mg/L)	Dissolved Copper (mg/L)	Dissolved Iron (mg/L)
Dry season 2004 base flow													
Duplicate	9/9/2004	0409-109	1345	1.000	0.200	0.0757	77.04	26.33	3.73	42.79	301	0.020	0.031
FC 1	9/9/2004	0409-108	1345	1.000	0.200	0.0527	76.62	26.27	3.79	42.94	299	0.020	0.034
FC 2	9/9/2004	0409-107	1300	1.000	0.200	0.0753	79.24	26.13	3.67	40.66	305	0.020	0.037
FC 3	9/9/2004	0409-106	1200	1.000	0.200	0.0509	72.53	24.83	3.91	36.72	283	0.020	0.052
FC 4	9/9/2004	0409-105	1140	1.000	0.200	0.0952	72.15	25.39	4.38	41.78	285	0.020	0.044
FC 5	9/9/2004	0409-104	1100	1.000	0.200	0.0936	72.19	24.91	3.11	15.45	283	0.020	0.084
FC 6	9/9/2004	0409-103	1030	1.000	0.101	0.0553	74.04	24.52	4.40	12.82	286	0.020	0.036
FC 7	9/9/2004	0409-102	950	1.000	0.200	0.0761	114.45	38.85	3.99	18.82	446	0.020	0.023
FC 8	9/9/2004	0409-101	915	1.000	0.200	0.2085	90.36	31.14	6.27	20.14	354	0.020	0.029
Duplicate	9/15/2004	0409-307	1330	1.000	0.200	0.0514	92.75	28.94	3.48	12.95	351	0.020	0.03
SB 1	9/15/2004	0409-306	1330	1.000	0.200	0.04	92.36	28.63	3.41	12.33	348	0.024	0.022
SB 2	9/15/2004	0409-305	1310	1.000	0.200	0.0901	105.90	30.38	3.69	12.32	390	0.020	0.096
SB 3	9/15/2004	-	-	-	-	-	-	-	-	-	-	-	-
SB 4	9/15/2004	0409-304	1240	1.000	0.200	0.887	62.22	28.03	4.98	24.74	271	0.020	0.131
SB 5	9/15/2004	0409-303	1220	1.000	0.116	0.0929	64.56	28.39	3.79	38.62	278	0.020	0.169
SB 6	9/15/2004	0409-302	1150	1.000	0.200	0.1347	77.81	27.39	2.44	18.01	307	0.020	0.044
SB 7	9/15/2004	0409-301	1045	1.000	0.200	1.5316	62.36	19.16	4.88	18.11	235	0.020	0.054
Outfall	10/13/2004	0410-305	1150	0.513	0.172	0.1965	32.81	5.14	2.33	3.50	103	0.020	0.026
SB 1	10/13/2004	0410-306	1248	1.500	0.300	0.0448	96.80	29.57	4.86	11.64	363	0.020	0.049
SB 2	10/13/2004	0410-304	1150	0.855	0.252	0.3515	78.44	20.92	4.35	13.59	282	0.020	0.056
SB 3	10/13/2004	-	-	-	-	-	-	-	-	-	-	-	-
SB 4	10/13/2004	0410-303	1100	1.500	0.767	0.06	74.78	37.40	64.97	31.26	341	0.020	0.167
SB 5	10/13/2004	0410-302	1047	1.500	0.608	0.06	69.14	32.04	6.48	79.72	305	0.020	0.07
SB 6	10/13/2004	0410-301	1011	1.500	0.117	0.0494	83.14	28.25	4.11	14.43	324	0.020	0.061
SB 7	10/13/2004	-	-	-	-	-	-	-	-	-	-	-	-

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Manganese (mg/L)	Total P (mg/L)	TKN (mg/L)	TOC (mg/L)	DOC (mg/L)	Total Coliform (colonies per 100 mL)	E. Coli (colonies per 100 mL)	Heterotrophic Plate Count (colonies per 100 mL)	Atrazine (ug/L)	Bromide (mg/L)
Dry season 2004 base flow													
Duplicate	9/9/2004	0409-109	1345	0.074	0.065	1.02	4.96	4.74	N/S	N/S	N/S	N/S	N/S
FC 1	9/9/2004	0409-108	1345	0.075	0.060	0.95	5.23	5.08	6310	100	4200	N/S	N/S
FC 2	9/9/2004	0409-107	1300	0.098	0.058	1.27	4.84	4.62	26020	410	8500	N/S	N/S
FC 3	9/9/2004	0409-106	1200	0.113	0.102	1.23	5.52	5.25	11870	850	13000	N/S	N/S
FC 4	9/9/2004	0409-105	1140	0.106	0.124	1.11	5.81	5.52	12230	850	9000	N/S	N/S
FC 5	9/9/2004	0409-104	1100	0.100	0.137	0.87	4.74	4.61	27840	0	34000	N/S	N/S
FC 6	9/9/2004	0409-103	1030	0.021	0.182	1.13	6.73	6.60	20140	960	17000	N/S	N/S
FC 7	9/9/2004	0409-102	950	0.130	0.065	1.07	3.36	3.13	72150	610	23500	N/S	N/S
FC 8	9/9/2004	0409-101	915	2.097	0.865	3.59	23.52	10.60	25950	100	46000	N/S	N/S
Duplicate	9/15/2004	0409-307	1330	0.023	0.063	1.17	4.89	4.82	N/S	N/S	N/S	N/S	N/S
SB 1	9/15/2004	0409-306	1330	0.022	0.058	1.21	4.66	4.55	23590	3500	20000	N/S	N/S
SB 2	9/15/2004	0409-305	1310	0.119	0.058	1.42	5.67	5.33	129970	1100	34000	N/S	N/S
SB 3	9/15/2004	-	-	-	-	-	-	-	-	-	-	-	-
SB 4	9/15/2004	0409-304	1240	0.529	0.479	2.76	6.97	6.48	72700	200	210000	N/S	N/S
SB 5	9/15/2004	0409-303	1220	0.569	0.422	2.02	9.48	9.03	27000	100	11000	N/S	N/S
SB 6	9/15/2004	0409-302	1150	0.511	0.227	2.08	4.97	4.76	13960	0	29000	N/S	N/S
SB 7	9/15/2004	0409-301	1045	0.715	0.212	4.62	13.40	12.10	7120	520	11000	N/S	N/S
Outfall	10/13/2004	0410-305	1150	0.020	0.142	3.27	8.48	7.53	241920	520	74000	N/S	N/S
SB 1	10/13/2004	0410-306	1248	0.020	0.091	1.35	7.93	7.63	54750	2400	34000	N/S	N/S
SB 2	10/13/2004	0410-304	1150	0.095	0.150	3.26	10.50	9.55	241920	1690	86000	N/S	N/S
SB 3	10/13/2004	-	-	-	-	-	-	-	-	-	-	-	-
SB 4	10/13/2004	0410-303	1100	0.296	2.509	19.9	30.90	22.40	98040	2620	510000	N/S	N/S
SB 5	10/13/2004	0410-302	1047	0.098	0.531	2.05	16.40	9.11	0	0	700	N/S	N/S
SB 6	10/13/2004	0410-301	1011	0.540	0.325	1.96	7.02	6.37	38730	1100	80000	N/S	N/S
SB 7	10/13/2004	-	-	-	-	-	-	-	-	-	-	-	-

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Alkalinity (mg/L)	pH	Turbidity (NTU)	Dissolved Silica (mg/L)	Total Silica (mg/L)	Total Suspended Solids (g/mL)	Flouride (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Nitrite (mg/L)
Dry season 2004 event flow													
FC 1	10/15/2004	0410-317	1323	252	8.00	6.6	8.06	10.70	4.8	0.277	76.32	30.08	0.200
FC 2	10/15/2004	0410-316	1304	220	8.01	3.8	7.82	7.82	3.6	0.249	63.95	26.11	0.200
FC 3	10/15/2004	0410-315	1243	152	7.87	6.6	5.50	5.70	10.0	0.162	39.47	19.02	0.200
FC 4	10/15/2004	0410-314	1221	154	7.87	5.4	4.58	4.76	5.6	0.149	38.2	14.04	0.200
FC 5	10/15/2004	0410-313	1203	248	7.95	4.9	7.82	8.54	4.8	0.173	31.98	19.52	0.200
FC 6	10/15/2004	0410-312	1052	216	7.67	22.0	2.61	2.92	19.2	0.273	24.14	18.61	0.200
FC 7	10/15/2004	0410-311	1023	180	7.67	32.0	8.06	8.06	34.8	0.326	16.36	47.87	0.200
FC 8	10/15/2004	0410-310	1000	308	7.68	22.0	10.41	11.30	36.0	0.238	36	44.2	0.200
FC 1	11/2/2004	0411-307	1430	210	7.95	7.3	9.31	9.57	5.6	0.203	72.4	30.1	0.000
FC 2	11/2/2004	0411-306	1410	208	7.93	5.6	9.31	9.84	4.0	0.216	70.4	28.2	0.000
FC 3	11/2/2004	0411-305	1340	200	7.80	18.0	9.05	9.84	41.6	0.195	66.9	28.3	0.000
FC 4	11/2/2004	0411-304	1315	172	7.68	8.9	9.84	10.10	6.8	0.208	90.6	46.6	0.000
FC 5	11/2/2004	0411-303	1255	238	7.67	7.5	12.60	13.30	14.4	0.206	32.2	17.7	0.000
FC 6	11/2/2004	0411-302	1205	216	7.76	2.7	11.00	11.60	3.2	0.277	27.4	50.6	0.000
FC 7	11/2/2004	0411-301	1115	240	7.57	11.0	11.30	11.00	9.6	0.300	23.9	56.6	0.000
FC 8	11/2/2004	-	-	-	-	-	-	-	-	-	-	-	-
Field Blank	11/2/2004	0411-300	700	5	6.03	0.1	0.00	0.00	0.0	0.981	68.2	45.1	0.000
SB 1	11/2/2004	0411-313	1730	146	8.01	15.0	7.82	7.82	12.8	0.25	22.2	32.6	0.000
SB 2	11/2/2004	0411-312	1705	166	7.81	17.0	8.30	8.54	16.0	0.26	28.0	34.9	0.000
SB 3	11/2/2004	0411-311	1640	212	7.78	9.9	10.40	10.70	9.2	0.14	29.43	30.72	0.000
SB 4	11/2/2004	0411-310	1620	200	7.90	22.0	10.40	10.70	22.0	0.28	37.2	49.0	0.000
SB 5	11/2/2004	0411-309	1605	198	7.71	13.0	9.31	9.31	8.8	0.15	22.8	28.2	0.000
SB 6	11/2/2004	0411-308	1540	202	7.43	19.0	8.79	9.84	12.4	0.16	20.2	22.9	0.000
SB 7	11/2/2004	-	-	-	-	-	-	-	-	-	-	-	-

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Station ID	Date	Sample ID	Time	Nitrate (mg/L)	Phosphate (mg/L)	Ammonia (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Total Hardness (mg/L)	Dissolved Copper (mg/L)	Dissolved Iron (mg/L)
Dry season 2004 event flow													
FC 1	10/15/2004	0410-317	1323	1.000	0.200	0.1885	84.17	28.56	6.67	48.30	328	0.020	0.06
FC 2	10/15/2004	0410-316	1304	1.000	0.200	0.1116	72.73	25.81	6.71	38.93	288	0.020	0.06
FC 3	10/15/2004	0410-315	1243	1.000	0.200	0.1706	49.43	19.38	4.36	19.64	203	0.020	0.059
FC 4	10/15/2004	0410-314	1221	1.000	0.200	0.2966	46.38	19.96	2.77	17.37	198	0.020	0.041
FC 5	10/15/2004	0410-313	1203	1.000	0.200	0.153	83.54	24.57	4.15	15.11	310	0.020	0.0456
FC 6	10/15/2004	0410-312	1052	1.000	0.200	0.1319	60.97	22.81	6.65	11.78	246	0.020	0.073
FC 7	10/15/2004	0410-311	1023	0.527	0.200	0.1009	63.95	19.91	3.30	9.40	242	0.020	0.042
FC 8	10/15/2004	0410-310	1000	0.983	0.200	0.1422	92.93	27.80	7.68	48.06	347	0.020	0.084
FC 1	11/2/2004	0411-307	1430	1.000	0.200	0.1502	73.64	21.50	4.63	40.47	272	0.020	0.0490
FC 2	11/2/2004	0411-306	1410	0.000	0.000	0.0462	70.98	20.77	4.62	40.23	263	0.020	0.0730
FC 3	11/2/2004	0411-305	1340	0.000	0.000	0.0836	66.66	20.81	4.93	40.15	252	0.020	0.0920
FC 4	11/2/2004	0411-304	1315	0.000	0.000	0.2694	60.05	18.30	5.05	64.16	225	0.020	0.0740
FC 5	11/2/2004	0411-303	1255	0.000	0.000	0.1911	74.27	23.22	7.82	17.09	281	0.020	0.2070
FC 6	11/2/2004	0411-302	1205	0.000	0.000	0.3031	75.13	24.14	5.72	15.39	287	0.020	0.0450
FC 7	11/2/2004	0411-301	1115	0.000	0.000	0.1268	81.31	27.06	8.31	16.71	314	0.020	0.2160
FC 8	11/2/2004	-	-	-	-	-	-	-	-	-	-	-	-
Field Blank	11/2/2004	0411-300	700	0.000	0.000	0.0400	3.18	2.40	0.24	2.40	22	0.020	0.0200
SB 1	11/2/2004	0411-313	1730	0.000	0.000	0.239	60.62	16.95	4.44	13.20	221	0.020	0.043
SB 2	11/2/2004	0411-312	1705	0.000	0.000	0.187	66.14	19.61	4.38	13.52	246	0.020	0.035
SB 3	11/2/2004	0411-311	1640	0.000	0.000	0.2544	78.61	23.10	4.43	14.87	291	0.020	0.038
SB 4	11/2/2004	0411-310	1620	0.000	0.000	0.204	76.02	25.47	6.30	17.92	295	0.020	0.024
SB 5	11/2/2004	0411-309	1605	0.000	0.000	0.356	77.28	22.11	2.89	8.65	284	0.020	0.022
SB 6	11/2/2004	0411-308	1540	5.479	0.000	0.149	75.60	21.47	1.82	4.96	277	0.020	0.020
SB 7	11/2/2004	-	-	-	-	-	-	-	-	-	-	-	-

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Manganese (mg/L)	Total P (mg/L)	TKN (mg/L)	TOC (mg/L)	DOC (mg/L)	Total Coliform (colonies per 100 mL)	E. Coli (colonies per 100 mL)	Heterotrophic Plate Count (colonies per 100 mL)	Atrazine (ug/L)	Bromide (mg/L)
Dry season 2004 event flow													
FC 1	10/15/2004	0410-317	1323	0.023	0.144	1.88	9.79	9.54	13740	840	11000	N/S	N/S
FC 2	10/15/2004	0410-316	1304	0.021	0.160	2.26	10.60	5.25	17890	2160	6500	N/S	N/S
FC 3	10/15/2004	0410-315	1243	0.020	0.150	1.82	9.23	9.54	21430	520	23000	N/S	N/S
FC 4	10/15/2004	0410-314	1221	0.032	0.112	1.93	6.31	6.83	24810	1890	19000	N/S	N/S
FC 5	10/15/2004	0410-313	1203	0.042	0.154	1.66	5.26	5.16	14210	100	3900	N/S	N/S
FC 6	10/15/2004	0410-312	1052	0.540	0.393	3.87	11.40	10.00	5650	100	17500	N/S	N/S
FC 7	10/15/2004	0410-311	1023	0.124	0.239	1.68	9.15	8.82	72700	11190	57000	N/S	N/S
FC 8	10/15/2004	0410-310	1000	1.124	0.405	3.04	12.80	11.90	129970	0	510000	N/S	N/S
FC 1	11/2/2004	0411-307	1430	0.020	0.125	0.92	7.60	7.22	68670	1200	970	N/S	N/S
FC 2	11/2/2004	0411-306	1410	0.020	0.114	0.96	7.56	7.35	64880	2780	630	N/S	N/S
FC 3	11/2/2004	0411-305	1340	0.025	0.158	1.18	8.42	8.03	51720	630	570	N/S	N/S
FC 4	11/2/2004	0411-304	1315	0.028	0.158	1.68	10.50	10.20	241920	14830	3600	N/S	N/S
FC 5	11/2/2004	0411-303	1255	0.537	0.450	1.50	12.60	11.90	32550	2160	510	N/S	N/S
FC 6	11/2/2004	0411-302	1205	0.020	0.299	1.00	9.02	8.59	54750	1610	1000	N/S	N/S
FC 7	11/2/2004	0411-301	1115	1.256	0.657	1.97	14.70	13.30	198630	3170	3100	N/S	N/S
FC 8	11/2/2004	-	-	-	-	-	-	-	-	-	-	-	-
Field Blank	11/2/2004	0411-300	700	0.020	0.010	0.24	0.50	1.40	0	0	0	N/S	N/S
SB 1	11/2/2004	0411-313	1730	0.020	0.150	1.51	7.56	7.10	173290.00	1750.00	1100.00	N/S	N/S
SB 2	11/2/2004	0411-312	1705	0.020	0.069	1.46	6.49	6.26	104620.00	1200.00	860.00	N/S	N/S
SB 3	11/2/2004	0411-311	1640	0.023	0.199	1.05	6.37	6.26	155310.00	3970.00	1700.00	N/S	N/S
SB 4	11/2/2004	0411-310	1620	0.021	0.237	1.40	6.88	6.62	141360.00	3690.00	800.00	N/S	N/S
SB 5	11/2/2004	0411-309	1605	0.020	0.174	1.13	5.76	5.50	104620.00	3010.00	1100.00	N/S	N/S
SB 6	11/2/2004	0411-308	1540	0.024	0.145	1.02	5.21	4.79	141360.00	5650.00	1400.00	N/S	N/S
SB 7	11/2/2004	-	-	-	-	-	-	-	-	-	-	-	-

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Alkalinity (mg/L)	pH	Turbidity (NTU)	Dissolved Silica (mg/L)	Total Silica (mg/L)	Total Suspended Solids (g/mL)	Flouride (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Nitrite (mg/L)
Wet season 2005 base flow													
Duplicate	3/21/2005	0503-312	1600	182	8.83	2.6	2.17	2.17	12.4	0.121	36.9	25.6	0.200
FC 1	3/21/2005	0503-309	1455	232	8.42	2.6	0.92	0.92	4.0	0.186	57.8	40.7	0.200
FC 2	3/21/2005	0503-308	1425	232	8.44	1.8	0.92	0.92	2.4	0.214	58.6	42.9	0.200
FC 3	3/21/2005	0503-307	1405	226	8.41	2.6	0.79	0.79	4.0	0.186	53.2	43.0	0.200
FC 4	3/21/2005	0503-306	1315	226	8.45	2.4	0.92	1.06	4.4	0.160	42.4	43.3	0.200
FC 5	3/21/2005	0503-305	1305	230	8.42	2.6	1.32	1.46	4.0	0.195	35.8	43.0	0.200
FC 6	3/21/2005	0503-304	1130	230	8.31	2.3	2.31	2.31	3.2	0.214	32.6	45.6	0.200
FC 7	3/21/2005	0503-303	1100	218	8.39	2.7	2.46	2.46	2.4	0.206	37.0	46.0	0.200
FC 8	3/21/2005	0503-302	940	244	8.44	4.3	3.72	3.72	3.2	0.172	40.2	43.6	0.200
SB 1	3/21/2005	0503-317	1800	202	8.44	2.7	2.46	2.31	3.2	0.203	25.7	39.8	0.200
SB 2	3/21/2005	0503-316	1740	200	8.54	2.6	1.32	1.32	5.6	0.173	34.6	31.4	0.200
SB 3	3/21/2005	0503-315	1705	168	8.57	7.8	2.31	2.46	8.4	0.184	21.7	35.2	0.200
SB 4	3/21/2005	0503-314	1640	192	8.60	3.9	1.06	1.06	7.6	0.135	32.1	26.1	0.200
SB 5	3/21/2005	0503-313	1620	200	8.61	1.8	1.74	1.88	3.6	0.133	33.1	25.5	0.200
SB 6	3/21/2005	0503-311	1600	186	8.82	8.0	2.17	2.17	12.0	0.147	37.1	25.8	0.200
SB 7	3/21/2005	0503-310	1520	192	8.62	5.4	1.88	1.88	12.8	0.143	42.5	27.2	0.200

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Nitrate (mg/L)	Phosphate (mg/L)	Ammonia (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Total Hardness (mg/L)	Dissolved Copper (mg/L)	Dissolved Iron (mg/L)
Wet season 2005 base flow													
Duplicate	3/21/2005	0503-312	1600	3.140	0.200	0.040	65.93	24.77	1.13	18.61	267	0.022	0.020
FC 1	3/21/2005	0503-309	1455	1.544	0.200	0.063	81.83	28.66	1.67	31.90	322	0.020	0.047
FC 2	3/21/2005	0503-308	1425	1.693	0.200	0.040	82.25	28.93	1.82	32.05	325	0.020	0.038
FC 3	3/21/2005	0503-307	1405	1.876	0.200	0.081	81.23	28.75	1.74	28.26	321	0.020	0.046
FC 4	3/21/2005	0503-306	1315	2.144	0.200	0.039	80.90	28.34	1.67	22.81	319	0.020	0.036
FC 5	3/21/2005	0503-305	1305	2.742	0.200	0.054	83.62	28.49	1.59	18.07	326	0.020	0.033
FC 6	3/21/2005	0503-304	1130	3.397	0.108	0.040	84.36	28.13	1.33	13.65	326	0.020	0.029
FC 7	3/21/2005	0503-303	1100	3.831	0.200	0.040	81.60	28.27	1.52	14.97	320	0.020	0.020
FC 8	3/21/2005	0503-302	940	3.303	0.200	0.020	89.81	29.07	1.11	16.12	344	0.020	0.020
SB 1	3/21/2005	0503-317	1800	1.973	0.200	0.067	73.68	23.72	1.83	12.16	282	0.020	0.021
SB 2	3/21/2005	0503-316	1740	3.794	0.200	0.040	71.33	25.13	1.42	16.76	282	0.020	0.020
SB 3	3/21/2005	0503-315	1705	2.519	0.200	0.029	61.81	19.20	2.19	9.31	233	0.020	0.022
SB 4	3/21/2005	0503-314	1640	4.291	0.200	0.023	69.97	25.56	1.10	13.08	280	0.020	0.020
SB 5	3/21/2005	0503-313	1620	4.518	0.200	0.040	72.13	25.71	1.18	15.78	286	0.020	0.020
SB 6	3/21/2005	0503-311	1600	3.184	0.200	0.046	65.45	24.57	1.08	16.05	265	0.020	0.025
SB 7	3/21/2005	0503-310	1520	3.155	0.200	0.105	68.04	25.08	1.06	21.90	273	0.020	0.020

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Manganese (mg/L)	Total P (mg/L)	TKN (mg/L)	TOC (mg/L)	DOC (mg/L)	Total Coliform (colonies per 100 mL)	E. Coli (colonies per 100 mL)	Heterotrophic Plate Count (colonies per 100 mL)	Atrazine (ug/L)	Bromide (mg/L)
Wet season 2005 base flow													
Duplicate	3/21/2005	0503-312	1600	0.020	0.041	0.84	3.03	2.82	369	10	340	N/S	100.00
FC 1	3/21/2005	0503-309	1455	0.039	0.026	0.79	3.34	3.22	98	41	900	N/S	101.09
FC 2	3/21/2005	0503-308	1425	0.038	0.028	0.8	3.29	3.07	187	0	450	N/S	102.17
FC 3	3/21/2005	0503-307	1405	0.039	0.025	1.01	3.71	3.43	243	10	800	N/S	105.44
FC 4	3/21/2005	0503-306	1315	0.044	0.031	1.55	3.67	3.45	2187	52	1500	N/S	101.09
FC 5	3/21/2005	0503-305	1305	0.037	0.028	0.6	3.09	2.92	1500	148	3400	N/S	101.09
FC 6	3/21/2005	0503-304	1130	0.037	0.026	0.75	2.86	2.60	2187	146	1450	N/S	101.09
FC 7	3/21/2005	0503-303	1100	0.024	0.034	0.85	3.61	3.36	880	74	1100	N/S	102.17
FC 8	3/21/2005	0503-302	940	0.034	0.033	0.61	2.50	2.44	836	95	1500	N/S	102.17
SB 1	3/21/2005	0503-317	1800	0.030	0.039	0.58	3.16	2.93	262	0	550	N/S	104.35
SB 2	3/21/2005	0503-316	1740	0.020	0.031	0.61	2.94	2.77	323	0	40	N/S	102.17
SB 3	3/21/2005	0503-315	1705	0.020	0.043	0.84	3.25	3.05	0	0	80	N/S	105.44
SB 4	3/21/2005	0503-314	1640	0.021	0.033	0.85	2.70	2.66	373	20	520	N/S	98.91
SB 5	3/21/2005	0503-313	1620	0.020	0.031	0.79	2.75	2.58	1968	132	380	N/S	105.44
SB 6	3/21/2005	0503-311	1600	0.020	0.059	0.93	3.13	2.88	419	63	950	N/S	100.00
SB 7	3/21/2005	0503-310	1520	0.020	0.057	0.96	3.05	2.87	1553	0	1150	N/S	103.26

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Alkalinity (mg/L)	pH	Turbidity (NTU)	Dissolved Silica (mg/L)	Total Silica (mg/L)	Total Suspended Solids (g/mL)	Flouride (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Nitrite (mg/L)
Wet season 2005 event flow													
Duplicate	4/22/2005	0504-318	1600	93	7.70	108.0	6.71	7.37	122.0	0.164	14.5	55.6	<0.100
FC 1	4/22/2005	0504-309	1315	181	7.90	218.0	3.39	3.56	393.0	0.169	47.0	38.3	<0.100
FC 2	4/22/2005	0504-308	1300	180	7.94	222.0	3.39	3.72	390.0	0.172	48.6	39.3	<0.100
FC 3	4/22/2005	0504-307	1230	181	7.83	180.0	3.39	3.56	341.0	0.158	39.5	30.9	<0.100
FC 4	4/22/2005	0504-306	1145	140	7.74	146.0	4.40	4.58	320.0	0.163	28.4	25.5	<0.100
FC 5	4/22/2005	0504-305	1130	112	7.68	234.0	5.89	6.30	364.0	0.193	19.6	18.8	<0.100
FC 6	4/22/2005	0504-304	1035	101	7.48	191.0	6.30	6.93	282.0	0.172	22.3	17.1	<0.100
FC 7	4/22/2005	0504-303	1000	99	7.46	188.0	6.93	7.37	190.0	0.177	24.4	15.9	<0.100
FC 8	4/22/2005	0504-302	930	95	7.41	95.7	7.37	8.06	85.6	0.182	22.4	16.1	<0.100
Field Blank	4/22/2005	0504-301	N/A	5	7.32	0.1	0.00	0.00	0.4	0.200	16.0	16.0	<0.100
SB 7	4/22/2005	0504-310	1345	119	7.37	37.7	7.82	8.06	20.0	0.160	23.1	16.3	<0.100
SB 1	4/22/2005	0504-317	1600	96	7.67	101.0	6.71	7.37	121.0	0.160	14.8	56.3	<0.100
SB 2	4/22/2005	0504-316	1520	91	7.47	76.6	6.93	7.59	77.0	0.172	15.5	57.9	<0.100
SB 3	4/22/2005	0504-315	1500	94	7.34	69.7	7.59	7.82	65.0	0.138	14.1	67.3	<0.100
SB 4	4/22/2005	0504-313	1445	91	7.37	71.5	7.82	8.06	57.0	0.158	14.7	67.5	<0.100
SB 5	4/22/2005	0504-312	1430	96	7.38	64.7	7.59	8.06	52.0	0.148	15.5	59.9	<0.100
SB 6	4/22/2005	0504-311	1415	106	7.28	72.2	7.82	8.30	36.0	0.162	19.2	18.6	<0.100

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Nitrate (mg/L)	Phosphate (mg/L)	Ammonia (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Total Hardness (mg/L)	Dissolved Copper (mg/L)	Dissolved Iron (mg/L)
Wet season 2005 event flow													
Duplicate	4/22/2005	0504-318	1600	11.200	<0.100	<0.100	64.05	14.30	4.53	BDL	219	0.020	0.048
FC 1	4/22/2005	0504-309	1315	2.220	<0.100	0.182	65.68	21.33	1.96	25.27	252	0.020	0.020
FC 2	4/22/2005	0504-308	1300	2.260	<0.100	0.187	67.83	22.20	2.06	26.15	261	0.020	0.020
FC 3	4/22/2005	0504-307	1230	2.110	<0.100	0.093	64.39	21.22	1.96	20.74	248	0.020	0.020
FC 4	4/22/2005	0504-306	1145	4.730	<0.100	0.398	54.96	16.86	2.63	13.61	207	0.020	0.020
FC 5	4/22/2005	0504-305	1130	9.790	<0.100	1.196	50.07	14.06	3.89	6.96	183	0.020	0.025
FC 6	4/22/2005	0504-304	1035		<0.100	0.816	48.43	13.28	3.61	8.03	176	0.020	0.036
FC 7	4/22/2005	0504-303	1000	9.790	<0.100	0.625	46.45	12.35	3.27	10.83	167	0.020	0.039
FC 8	4/22/2005	0504-302	930	8.330	<0.100	0.257	44.16	11.89	3.38	9.84	159	0.020	0.064
Field Blank	4/22/2005	0504-301	N/A	0.500	<0.100	<0.100	4.57	2.40	BDL	2.40	13	0.020	0.020
SB 7	4/22/2005	0504-310	1345	14.500	<0.100	0.855	59.52	16.33	2.60	7.22	216	0.020	0.041
SB 1	4/22/2005	0504-317	1600	11.200	<0.100	<0.100	64.52	14.49	4.58	BDL	221	0.020	0.050
SB 2	4/22/2005	0504-316	1520	11.900	<0.100	<0.100	64.29	14.25	4.56	BDL	219	0.020	0.031
SB 3	4/22/2005	0504-315	1500	13.400	<0.100	0.794	67.40	14.55	4.57	3.90	228	0.020	0.039
SB 4	4/22/2005	0504-313	1445	13.800	<0.100	<0.100	71.17	15.64	4.76	BDL	242	0.020	0.042
SB 5	4/22/2005	0504-312	1430	14.200	<0.100	<0.100	69.83	15.52	4.53	BDL	238	0.020	0.027
SB 6	4/22/2005	0504-311	1415	14.300	<0.100	0.935	56.09	14.53	3.22	5.52	200	0.020	0.037

Veolia Labs, Indianapolis LCC Water Quality Analysis Data Continued

Station ID	Date	Sample ID	Time	Manganese (mg/L)	Total P (mg/L)	TKN (mg/L)	TOC (mg/L)	DOC (mg/L)	Total Coliform (colonies per 100 mL)	E. Coli (colonies per 100 mL)	Heterotrophic Plate Count (colonies per 100 mL)	Atrazine (ug/L)	Bromide (mg/L)
Wet season 2005 event flow													
Duplicate	4/22/2005	0504-318	1600	0.020	0.475	3.09	7.03	6.92	198630	1340	210000	N/S	N/S
FC 1	4/22/2005	0504-309	1315	0.020	0.635	3.32	5.26	4.37	57480	2500	40000	0.76	N/S
FC 2	4/22/2005	0504-308	1300	0.020	0.671	3.65	5.32	4.52	40340	2030	150000	1.80	N/S
FC 3	4/22/2005	0504-307	1230	0.020	0.590	2.58	5.37	4.50	54930	5980	100000	2.40	N/S
FC 4	4/22/2005	0504-306	1145	0.020	0.559	3	5.99	5.23	129970	5980	260000	35.00	N/S
FC 5	4/22/2005	0504-305	1130	0.020	1.030	4.36	6.73	6.35	155310	2950	150000	31.00	N/S
FC 6	4/22/2005	0504-304	1035	0.020	0.848	3.6	6.86	6.29	120330	2880	360000	33.00	N/S
FC 7	4/22/2005	0504-303	1000	0.020	0.663	2.92	6.86	6.57	198630	2410	150000	28.00	N/S
FC 8	4/22/2005	0504-302	930	0.020	0.422	2.41	7.13	6.84	241920	3550	310000	25.00	N/S
Field Blank	4/22/2005	0504-301	N/A	0.020	0.022	0.1	0.50	0.50	N/S	N/S	N/S	0.04	N/S
SB 7	4/22/2005	0504-310	1345	0.020	0.341	2.61	7.30	6.45	241920	2920	260000	N/S	N/S
SB 1	4/22/2005	0504-317	1600	0.020	0.460	2.87	6.99	6.98	155310	2620	310000	N/S	N/S
SB 2	4/22/2005	0504-316	1520	0.020	0.425	3.01	7.09	7.05	173290	1220	360000	N/S	N/S
SB 3	4/22/2005	0504-315	1500	0.020	0.373	2.94	7.34	7.18	241920	1990	260000	N/S	N/S
SB 4	4/22/2005	0504-313	1445	0.020	0.341	3.17	7.34	7.25	155310	2330	40000	N/S	N/S
SB 5	4/22/2005	0504-312	1430	0.020	0.370	3.05	7.08	7.01	87040	3230	57000	N/S	N/S
SB 6	4/22/2005	0504-311	1415	0.020	0.370	2.96	7.17	7.19	241920	2810	51000	N/S	N/S

Appendix C. Bound and Adsorbed Suspended Sediment Geochemistry

Bound Suspended Sediment Geochemistry

Station ID	Sample Number	Date Collected	Phosphate (mg/g)	Iron (ug/g)	Copper (ug/g)	Lead (ug/g)	Cadmium (ug/g)	Sulfate (ug/g)	Manganese (ug/g)	Zinc (ug/g)	Barium (ug/g)
DUP	0604-353	6/11/2004	0.30	<11.00	38.82	-	20.73	<79.00	<3.00	22.16	48.23
SB 1	0604-349	6/11/2004	0.12	<11.00	<22.00	<12.00	7.65	<79.00	<3.00	<36.00	17.88
SB 1	0604-357	6/11/2004	1.34	221.68	<22.00	41.27	14.90	1236.60	33.02	174.75	16.90
SB 2	0604-348	6/11/2004	<0.10	<11.00	<22.00	<12.00	6.42	<79.00	<3.00	<36.00	15.19
SB 2	0604-356	6/11/2004	1.37	18347.39	24.91	-	15.49	1332.33	450.87	157.42	71.45
SB 3	0604-347	6/11/2004	0.15	<11.00	<22.00	<12.00	10.51	<79.00	<3.00	<36.00	23.37
SB 3	0604-355	6/11/2004	0.15	<11.00	<22.00	<12.00	9.88	<79.00	<3.00	<36.00	22.03
SB 4	0604-346	6/11/2004	1.55	18827.20	27.78	39.88	19.99	1190.19	443.96	206.52	88.23
SB 4	0604-354	6/11/2004	2.26	27996.21	38.13	57.77	28.72	1879.84	576.60	264.25	116.07
SB 5	0604-345	6/11/2004	0.40	29.07	26.29	91.21	170.93	-	15.58	145.15	32.67
SB 5	0604-352	6/11/2004	0.24	<11.00	39.21	<12.00	21.92	<79.00	<3.00	-	110.46
SB 6	0604-344	6/11/2004	2.25	16799.48	36.93	71.13	35.97	1823.73	322.38	234.86	86.63
SB 6	0604-351	6/11/2004	2.45	20912.53	31.79	-	38.85	2111.72	295.29	224.05	116.76
SB 7	0604-343	6/11/2004	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	10.78
SB 7	0604-350	6/11/2004	2.68	35587.44	52.78	-	37.86	1633.18	393.42	263.46	142.31
DUP	0604-366	6/16/2004	1.09	20181.45	31.71	34.11	8.08	1514.59	606.17	154.04	65.28
FC 1	0604-365	6/16/2004	0.65	13997.65	<22.00	19.81	5.93	905.16	436.52	95.45	48.67
FC 1A	0604-367	6/16/2004	0.93	22577.50	27.80	26.92	8.52	1200.78	633.64	123.83	73.06
FC 2	0604-364	6/16/2004	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	6.29
FC 3	0604-363	6/16/2004	0.97	21404.43	27.85	24.92	9.79	1021.81	589.40	125.98	76.24
FC 4	0604-362	6/16/2004	1.12	15318.30	23.76	-	14.55	1157.03	519.16	134.10	63.19
FC 5	0604-361	6/16/2004	0.11	<11.00	<22.00	<12.00	8.28	<79.00	<3.00	<36.00	19.60
FC 6	0604-360	6/16/2004	1.02	18399.91	26.95	26.22	10.95	866.46	642.28	181.03	84.15
FC 7	0604-359	6/16/2004	0.18	<11.00	24.60	<12.00	13.48	<79.00	<3.00	<36.00	28.06
FC 8	0604-358	6/16/2004	2.14	28239.85	56.25	-	42.59	1919.09	638.69	218.37	142.17

Bound Suspended Sediment Geochemistry Continued

Station ID	Sample Number	Date Collected	Phosphate (mg/g)	Iron (ug/g)	Copper (ug/g)	Lead (ug/g)	Cadmium (ug/g)	Sulfate (ug/g)	Manganese (ug/g)	Zinc (ug/g)	Barium (ug/g)
DUP	0604-374	6/17/2004	0.27	<11.00	35.16	<12.00	19.30	-	<3.00	<36.00	42.67
FC 1	0604-376	6/17/2004	0.16	<11.00	<22.00	<12.00	10.75	<79.00	<3.00	<36.00	28.14
FC 1A	0604-377	6/17/2004	0.18	<11.00	<22.00	<12.00	11.41	<79.00	<3.00	<36.00	27.63
FC 2	0604-375	6/17/2004	1.14	18870.03	27.34	-	21.37	1021.40	682.04	127.53	84.38
FC 3	0604-373	6/17/2004	1.54	21315.94	34.88	-	26.69	1075.54	723.97	184.85	100.49
FC 4	0604-372	6/17/2004	1.48	24373.39	41.79	-	28.74	994.18	831.42	190.59	120.39
FC 5	0604-371	6/17/2004	1.35	17170.40	29.55	-	30.97	1277.20	592.18	149.94	92.41
FC 6	0604-370	6/17/2004	0.64	<11.00	83.93	-	42.33	<79.00	<3.00	<36.00	83.46
FC 7	0604-369	6/17/2004	0.54	<11.00	72.27	-	38.79	-	<3.00	<36.00	96.52
FC 8	0604-368	6/17/2004	0.70	<11.00	88.51	-	50.72	<79.00	<3.00	38.06	118.59
Outfall A	0410-305	10/13/2004	0.49	<11.00	56.42	<12.00	32.10	<79.00	<3.00	<36.00	74.55
SB 1	0410-306	10/13/2004	<0.10	<11.00	<22.00	<12.00	6.67	<79.00	<3.00	<36.00	23.18
SB 2	0410-304	10/13/2004	12.58	27314.21	175.25	387.81	217.73	7052.79	2744.88	315280.14	295855.41
SB 4	0410-303	10/13/2004	15.43	21247.01	73.51	-	105.30	5337.79	1123.72	133452.44	120082.51
SB 5	0410-302	10/13/2004	<0.10	<11.00	<22.00	<12.00	9.25	<79.00	<3.00	<36.00	28.42
SB 6	0410-301	10/13/2004	14.38	21617.78	161.44	316.53	202.62	5626.04	3074.09	266687.61	243623.28
FC 1	0410-317	10/15/2004	12.33	14334.04	111.03	312.25	148.32	7559.17	1787.47	290108.79	228828.28
FC 2	0410-316	10/15/2004	11.92	8590.89	134.28	394.27	219.78	5405.24	1006.84	286169.19	283416.83
FC 3	0410-315	10/15/2004	14.64	15372.87	150.30	399.36	262.99	6718.49	1569.53	365089.02	323252.02
FC 4	0410-314	10/15/2004	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	13.95
FC 5	0410-313	10/15/2004	12.30	11737.10	125.09	281.41	244.08	6043.51	2043.09	267510.19	214275.20
FC 6	0410-312	10/15/2004	9.07	26481.97	79.62	172.63	113.58	4115.57	997.20	158266.89	167063.04
FC 7	0410-311	10/15/2004	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	7.37
FC 8	0410-310	10/15/2004	4.53	16724.97	89.50	89.23	44.63	2150.07	2350.38	55541.01	53974.38

Bound Suspended Sediment Geochemistry Continued

Station ID	Sample Number	Date Collected	Phosphate (mg/g)	Iron (ug/g)	Copper (ug/g)	Lead (ug/g)	Cadmium (ug/g)	Sulfate (ug/g)	Manganese (ug/g)	Zinc (ug/g)	Barium (ug/g)
FC 1	0411-307	11/2/2004	9.25	14059.63	88.56	271.91	124.60	5405.93	905.97	247631.19	204405.51
FC 2	0411-306	11/2/2004	24.93	24914.31	234.25	621.13	466.32	12718.14	1786.64	625165.30	510527.04
FC 3	0411-305	11/2/2004	<0.10	<11.00	<22.00	<12.00	12.63	<79.00	<3.00	<36.00	30.48
FC 4	0411-304	11/2/2004	10.49	15967.85	114.93	240.69	125.12	6189.12	1729.02	246582.67	188972.61
FC 5	0411-303	11/2/2004	16.04	29869.04	102.76	-	183.87	7170.78	10863.16	261282.18	220311.33
FC 6	0411-302	11/2/2004	2.25	<11.00	271.33	-	158.86	-	<3.00	126.39	374.19
FC 7	0411-301	11/2/2004	13.89	20184.56	65.80	153.23	84.73	8057.34	6581.47	168371.09	114689.22
SB 1	0411-313	11/2/2004	0.14	2.99	<22.00	<12.00	9.14	<79.00	<3.00	<36.00	22.18
SB 2	0411-312	11/2/2004	8.25	18434.47	96.24	-	141.03	3940.72	906.19	191701.83	162448.38
SB 3	0411-311	11/2/2004	<0.10	<11.00	<22.00	<12.00	6.14	<79.00	<3.00	<36.00	17.64
SB 4	0411-310	11/2/2004	1.01	<11.00	154.21	-	75.12	<79.00	<3.00	70.45	216.63
SB 5	0411-309	11/2/2004	10.29	16360.03	109.58	197.84	198.95	5239.15	638.63	237316.74	213797.12
SB 6	0411-308	11/2/2004	<0.10	<11.00	<22.00	<12.00	8.18	<79.00	<3.00	<36.00	18.93
FC 1	0504-309	4/22/2005	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	4.36
FC 1B	0504-309	4/22/2005	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	4.42
FC 1C	0504-309	4/22/2005	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	3.77
FC 1D	0504-309	4/22/2005	<0.10		<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	45.36
FC 1E	0504-309	4/22/2005	0.63	8710.00	<22.00	20.34	7.03	1084.95	463.25	8883.41	8444.64
FC 2	0504-308	4/22/2005	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	8.67
FC 3	0504-307	4/22/2005	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	4.86
FC 4	0504-306	4/22/2005	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	6.48
FC 4D	0504-306	4/22/2005	0.86	7253.40	17.10	15.56	10.25	784.71	436.74	12246.01	10910.89
FC 4E	0504-306	4/22/2005	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	7.22
FC 5	0504-305	4/22/2005	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	4.42
FC 6	0504-304	4/22/2005	0.90	14785.43	<22.00	22.39	6.58	894.42	499.55	115.67	72.40
FC 7	0504-303	4/22/2005	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	8.23
FC 7B	0504-303	4/22/2005	1.12	17637.71	<22.00	20.01	8.05	1021.83	540.91	148.79	79.05
FC 7C	0504-303	4/22/2005	0.67	9274.19	<22.00	-	6.71	663.64	270.41	83.73	39.45
FC 7D	0504-303	4/22/2005	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	11.70
FC 7E	0504-303	4/22/2005	<0.10	<11.00	<22.00	<12.00	<5.00	159.55	<3.00	<36.00	7.64
FC 8	0504-302	4/22/2005	1.49	21890.81	29.22	39.19	14.08	930.79	451.81	206.08	97.89

Bound Suspended Sediment Geochemistry Continued

Station ID	Sample Number	Date Collected	Phosphate (mg/g)	Iron (ug/g)	Copper (ug/g)	Lead (ug/g)	Cadmium (ug/g)	Sulfate (ug/g)	Manganese (ug/g)	Zinc (ug/g)	Barium (ug/g)
SB 1	0504-317	4/22/2005	0.19	15.19	<22.00	40.06	78.36	<79.00	9.47	53.25	26.15
SB 1B	0504-317	4/22/2005	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	12.88
SB 1C	0504-317	4/22/2005	1.16	21938.37	30.87	29.09	9.95	1263.34	454.04	173.90	83.19
SB 2	0504-316	4/22/2005	1.28	22803.85	36.82	33.68	11.72	1105.81	363.76	187.02	89.99
SB 3	0504-315	4/22/2005	0.13	<11.00	<22.00	<12.00	8.50	<79.00	<3.00	<36.00	18.37
SB 3B	0504-315	4/22/2005	0.13	<11.00	<22.00	<12.00	8.00	<79.00	<3.00	<36.00	18.69
SB 3C	0504-315	4/22/2005	<0.10	<11.00	<22.00	<12.00	<5.00	<79.00	<3.00	<36.00	9.37
SB 3E	0504-315	4/22/2005	2.61	14354.65	40.65	-	40.67	1296.67	261.38	55423.62	50773.31
SB 4	0504-313	4/22/2005	1.63	27547.21	34.24	-	16.17	1224.15	383.61	221.32	109.30
SB 5	0504-312	4/22/2005	0.13	<11.00	<22.00	<12.00	9.22	<79.00	<3.00	<36.00	24.95
SB 6	0504-311	4/22/2005	1.83	32919.70	40.04	54.77	21.35	1097.81	330.71	241.63	135.51
SB 6B	0504-311	4/22/2005	<0.10	<11.00	<22.00	<12.00	9.70	<79.00	<3.00	<36.00	23.21
SB 6C	0504-311	4/22/2005	1.52	22085.43	27.99	47.18	16.54	881.37	258.37	204.01	87.80
SB 6D	0504-311	4/22/2005	0.13	<11.00	<22.00	<12.00	9.71	<79.00	<3.00	<36.00	30.83
SB 6E	0504-311	4/22/2005	0.15	<11.00	<22.00	<12.00	9.97	<79.00	<3.00	<36.00	27.50
SB 7	0504-310	4/22/2005	2.56	31429.44	42.17	-	36.90	1672.26	256.67	419.32	286.94

Adsorbed Suspended Sediment Geochemistry

Station ID	Sample Number	Date Collected	Phosphate (mg/g)	Iron (ug/g)	Copper (ug/g)	Lead (ug/g)	Cadmium (ug/g)	Sulfate (ug/g)	Manganese (ug/g)	Zinc (ug/g)	Barium (ug/g)
DUP	0604-353	6/11/04	0.78	409.08	<20.00	-	77.05	1470.43	405.19	<26.00	109.94
SB 1	0604-349	6/11/04	0.32	124.51	<20.00	<47.00	28.75	728.15	261.09	-	85.06
SB 1	0604-357	6/11/04	0.30	<107.00	<20.00	-	-	339.12	<51.00	<26.00	<21.00
SB 2	0604-348	6/11/04	0.35	<107.00	<20.00	-	30.76	-	220.70	-	62.99
SB 2	0604-356	6/11/04	0.35	236.28	<20.00	<47.00	40.71	715.84	260.33	<26.00	106.19
SB 3	0604-347	6/11/04	0.42	137.27	<20.00	-	41.95	-	254.82	<26.00	62.95
SB 3	0604-355	6/11/04	0.41	156.44	<20.00	<47.00	29.71	-	246.45	<26.00	88.59
SB 4	0604-346	6/11/04	0.52	330.41	<20.00	-	59.67	-	379.99	48.94	114.47
SB 4	0604-354	6/11/04	0.44	415.55	16.51	-	49.46	-	353.62	<26.00	138.44
SB 5	0604-345	6/11/04	0.45	<107.00	<20.00	-	53.43	690.90	<51.00	<26.00	<21.00
SB 5	0604-352	6/11/04	0.59	203.61	<20.00	-	50.23	1295.26	256.65	-	67.21
SB 6	0604-344	6/11/04	0.60	537.35	<20.00	-	76.47	1117.78	445.85	52.43	132.50
SB 6	0604-351	6/11/04	0.67	795.87	36.72	161.40	108.83	575.22	526.12	64.83	182.73
SB 7	0604-343	6/11/04	0.29	<107.00	<20.00	<47.00	16.83	-	206.04	<26.00	65.50
SB 7	0604-350	6/11/04	0.43	603.81	26.09	-	83.03	-	397.73	58.83	165.54
DUP	0604-366	6/16/04	0.15	<107.00	<20.00	<47.00	<13.00	338.21	160.17	<26.00	64.26
FC 1	0604-365	6/16/04	0.13	<107.00	<20.00	<47.00	<13.00	-	179.82	<26.00	61.27
FC 1A	0604-367	6/16/04	0.12	<107.00	<20.00	<47.00	<13.00	-	133.20	<26.00	48.30
FC 2	0604-364	6/16/04	0.09	<107.00	<20.00	<47.00	<13.00	-	141.26	<26.00	52.48
FC 3	0604-363	6/16/04	0.15	<107.00	<20.00	<47.00	<13.00	423.48	173.36	<26.00	60.11
FC 4	0604-362	6/16/04	0.30	203.26	<20.00	<47.00	31.66	422.22	348.81	<26.00	90.77
FC 5	0604-361	6/16/04	0.31	133.14	<20.00	<47.00	28.82	-	349.06	<26.00	83.05
FC 6	0604-360	6/16/04	0.20	<107.00	<20.00	<47.00	18.99	-	282.04	<26.00	69.94
FC 7	0604-359	6/16/04	0.41	166.60	<20.00	<47.00	47.22	-	288.54	-	64.96
FC 8	0604-358	6/16/04	0.37	616.04	<20.00	-	86.60	-	501.52	33.54	161.14

Adsorbed Suspended Sediment Geochemistry Continued

Station ID	Sample Number	Date Collected	Phosphate (mg/g)	Iron (ug/g)	Copper (ug/g)	Lead (ug/g)	Cadmium (ug/g)	Sulfate (ug/g)	Manganese (ug/g)	Zinc (ug/g)	Barium (ug/g)
DUP	0604-374	6/17/04	0.40	306.85	<20.00	<47.00	49.93	-	476.78	<26.00	91.74
FC 1	0604-376	6/17/04	0.29	181.79	<20.00	<47.00	37.02	763.22	385.20	<26.00	75.91
FC 1A	0604-377	6/17/04	0.29	284.76	<20.00	-	42.66	-	363.15	<26.00	102.84
FC 2	0604-375	6/17/04	0.34	309.24	<20.00	-	58.30	844.93	413.94	<26.00	112.43
FC 3	0604-373	6/17/04	0.42	385.51	<20.00	-	63.88	823.62	411.78	31.72	104.86
FC 4	0604-372	6/17/04	0.39	460.27	26.20	-	70.73	937.52	514.78	34.67	142.68
FC 5	0604-371	6/17/04	0.42	467.36	<20.00	-	79.84	-	536.91	31.08	133.55
FC 6	0604-370	6/17/04	0.59	661.48	<20.00	<47.00	135.57	-	652.14	-	112.37
FC 7	0604-369	6/17/04	0.78	692.31	<20.00	-	160.86	-	624.30	29.54	93.33
FC 8	0604-368	6/17/04	0.64	859.12	<20.00	-	177.66	-	810.92	50.66	94.81
Outfall A	0410-305	10/13/04	1.20	482.37	<20.00	-	94.93	-	641.72	1564.54	2821.54
SB 1	0410-306	10/13/04	0.35	<107.00	<20.00	<47.00	21.02	758.32	560.34	187.56	1454.78
SB 2	0410-304	10/13/04	1.52	884.79	<20.00	-	172.15	-	1179.86	1800.46	4889.59
SB 4	0410-303	10/13/04	5.62	717.00	37.20	174.26	113.29	2263.32	1042.62	2282.70	2072.53
SB 5	0410-302	10/13/04	0.91	161.24	<20.00	<47.00	34.91	613.99	1440.99	135.38	1053.45
SB 6	0410-301	10/13/04	8.87	1460.60	106.68	444.25	198.17	7903.16	11697.92	2706.27	9418.31
FC 1	0410-317	10/15/04	2.33	394.77	21.86	<47.00	96.15	1907.49	1428.18	1226.12	5350.98
FC 2	0410-316	10/15/04	1.62	1468.36	88.73	457.99	233.58	1048.38	1173.26	3919.54	4843.22
FC 3	0410-315	10/15/04	1.85	969.50	<20.00	<47.00	180.25		1703.50	4271.50	7465.39
FC 4	0410-314	10/15/04	1.13	69.80	<20.00	<47.00	18.53	867.68	344.41	341.88	1226.25
FC 5	0410-313	10/15/04	2.15	2609.58	109.74	-	396.77	-	2948.00	5807.59	9201.03
FC 6	0410-312	10/15/04	2.26	740.67	36.78	-	91.55	-	1200.32	2129.97	2788.02
FC 7	0410-311	10/15/04	0.33	<107.00	<20.00	<47.00	<13.00	411.89	293.09	55.66	571.15
FC 8	0410-310	10/15/04	1.32	308.29	24.44	-	54.43	960.66	1188.83	287.49	756.52

Adsorbed Suspended Sediment Geochemistry Continued

Station ID	Sample Number	Date Collected	Phosphate (mg/g)	Iron (ug/g)	Copper (ug/g)	Lead (ug/g)	Cadmium (ug/g)	Sulfate (ug/g)	Manganese (ug/g)	Zinc (ug/g)	Barium (ug/g)
FC 1	0411-307	11/2/04	0.90	496.20	23.45	-	69.04	1826.32	822.27	1377.40	6334.82
FC 2	0411-306	11/2/04	2.12	3398.08	160.40	-	512.88	-	2517.25	8902.65	13276.29
FC 3	0411-305	11/2/04	0.68	269.12	<20.00	<47.00	38.80	1171.13	509.65	248.96	1398.17
FC 4	0411-304	11/2/04	1.14	311.81	<20.00	<47.00	70.05	-	1452.35	2167.95	5626.35
FC 5	0411-303	11/2/04	2.72	1134.17	31.98	-	149.85	-	5344.94	1732.23	3490.97
FC 6	0411-302	11/2/04	4.19	2388.25	<20.00	-	509.63	-	4544.67	14899.14	14982.15
FC 7	0411-301	11/2/04	1.07	251.18	<20.00	<47.00	36.21	760.96	1013.45	424.03	981.50
SB 1	0411-313	11/2/04	0.72	124.97	<20.00	<47.00	26.38	817.09	300.54	499.73	1905.54
SB 2	0411-312	11/2/04	0.83	846.04	15.25	-	106.50	-	435.04	1229.74	2070.17
SB 3	0411-311	11/2/04	0.82	<107.00	<20.00	<47.00	18.00	671.43	308.23	164.76	817.02
SB 4	0411-310	11/2/04	2.59	963.23	<20.00	548.63	291.35	4114.94	1224.79	3135.51	3521.59
SB 5	0411-309	11/2/04	1.20	1378.25	31.09	268.71	359.84	-	780.07	2538.21	2992.11
SB 6	0411-308	11/2/04	0.56	181.70	<20.00	<47.00	38.30	771.08	235.52	1288.16	3110.07
FC 1B	0504-309	4/22/05	0.11	<107.00	<20.00	<47.00	<13.00	355.06	188.45	<26.00	62.54
FC 1D	0504-309	4/22/05	<0.04	<107.00	<20.00	<47.00	<13.00	<296.00	76.32	<26.00	144.38
FC 1E	0504-309	4/22/05	0.12	<107.00	<20.00	<47.00	<13.00	304.04	151.93	<26.00	409.94
FC 2	0504-308	4/22/05	0.15	<107.00	<20.00	<47.00	<13.00	435.96	195.79	<26.00	68.49
FC 3	0504-307	4/22/05	0.12	<107.00	<20.00	<47.00	<13.00	323.18	273.14	<26.00	83.46
FC 4	0504-306	4/22/05	0.27	<107.00	<20.00	<47.00	<13.00	<296.00	267.50	<26.00	80.21
FC 4C	0504-306	4/22/05	0.29	<107.00	<20.00	<47.00	<13.00	472.42	273.19	<26.00	80.64
FC 4D	0504-306	4/22/05	0.24	<107.00	<20.00	<47.00	<13.00	<296.00	205.65	36.12	431.33
FC 4E	0504-306	4/22/05	0.36	<107.00	<20.00	<47.00	<13.00	356.84	243.53	35.46	554.09
FC 5	0504-305	4/22/05	0.22	<107.00	<20.00	<47.00	<13.00	<296.00	175.92	<26.00	67.91
FC 6	0504-304	4/22/05	0.23	<107.00	<20.00	<47.00	<13.00	376.62	171.66	<26.00	<21.00
FC 7	0504-303	4/22/05	0.22	<107.00	<20.00	<47.00	<13.00	303.49	183.86	<26.00	77.81
FC 7B	0504-303	4/22/05	0.26	<107.00	<20.00	<47.00	14.32	-	213.31	<26.00	94.48
FC 7C	0504-303	4/22/05	0.28	<107.00	<20.00	<47.00	21.39	518.61	245.66	<26.00	81.48
FC 7D	0504-303	4/22/05	0.33	270.05	<20.00	<47.00	21.60	456.38	181.54	64.04	610.66
FC 7E	0504-303	4/22/05	0.31	<107.00	<20.00	<47.00	14.79	367.71	207.47	64.87	690.21
FC 8	0504-302	4/22/05	0.35	136.19	<20.00	<47.00	31.19	596.47	328.43	<26.00	127.72

Adsorbed Suspended Sediment Geochemistry Continued

Station ID	Sample Number	Date Collected	Phosphate (mg/g)	Iron (ug/g)	Copper (ug/g)	Lead (ug/g)	Cadmium (ug/g)	Sulfate (ug/g)	Manganese (ug/g)	Zinc (ug/g)	Barium (ug/g)
SB 1	0504-317	4/22/05	0.53	<107.00	<20.00	56.62	<13.00	772.09	<51.00	<26.00	<21.00
SB 1B	0504-317	4/22/05	0.31	<107.00	<20.00	<47.00	13.42	590.24	143.70	<26.00	62.09
SB 1C	0504-317	4/22/05	0.26	<107.00	<20.00	<47.00	13.18	-	166.54	<26.00	90.44
SB 2	0504-316	4/22/05	0.34	166.60	<20.00	<47.00	21.04	648.24	182.83	<26.00	111.93
SB 3	0504-315	4/22/05	0.35	207.28	<20.00	-	27.47	488.78	163.99	<26.00	100.12
SB 3B	0504-315	4/22/05	0.36	122.07	<20.00	<47.00	32.72	793.24	181.99	<26.00	92.83
SB 3C	0504-315	4/22/05	0.18	<107.00	<20.00	<47.00	<13.00	460.25	88.84	<26.00	47.97
SB 3D	0504-315	4/22/05	0.38	<107.00	<20.00	<47.00	24.07	888.27	117.17	222.01	1413.15
SB 3E	0504-315	4/22/05	0.40	248.62	<20.00	<47.00	34.42	836.72	182.42	279.19	1531.22
SB 5	0504-312	4/22/05	0.39	<107.00	<20.00	-	<13.00	-	<51.00	<26.00	<21.00
SB 6	0504-311	4/22/05	0.34	270.28	<20.00	-	36.71	-	197.08	<26.00	146.17
SB 6B	0504-311	4/22/05	0.38	187.17	<20.00	<47.00	40.48	544.96	179.64	<26.00	116.18
SB 6C	0504-311	4/22/05	0.30	269.39	<20.00	<47.00	35.77	445.19	219.19	33.79	160.01
SB 6D	0504-311	4/22/05	0.49	164.69	<20.00	<47.00	37.25	-	149.95	295.30	1854.54
SB 6E	0504-311	4/22/05	0.46	148.46	<20.00	<47.00	30.75	-	146.84	368.41	1073.94
SB 7	0504-310	4/22/05	0.48	519.39	<20.00	124.74	57.82	863.92	221.55	67.16	195.57

Appendix D. Continuous monitoring data for sampling dates.

Fishback Creek Wet Season Base A - No data available for 5/12/2004

School Branch Wet Season Base A

	Station SB 1									Station SB 3			
DateTime	Temp (ºC)	SpCond (mS/cm)	DO (mg/L)	DO Test (mV)	Pressure (psig)	Depth (m)	pH	pH Test (mV)	ORP (mV)	Temp (ºC)	SpCond (mS/cm)	Pressure (psig)	Depth (m)
6/9/04 10:00	21.45	0.636	-	-	0.12	0.088	-	-	-	-	-	-	-
6/9/04 10:15	21.53	0.635	-	-	0.12	0.088	-	-	-	-	-	-	-
6/9/04 10:30	21.58	0.635	-	-	0.12	0.088	-	-	-	-	-	-	-
6/9/04 10:45	21.61	0.635	-	-	0.13	0.089	-	-	-	-	-	-	-
6/9/04 11:00	21.71	0.635	-	-	0.13	0.089	-	-	-	-	-	-	-
6/9/04 11:15	21.71	0.634	-	-	0.13	0.091	-	-	-	-	-	-	-
6/9/04 11:30	21.76	0.635	-	-	0.13	0.091	-	-	-	-	-	-	-
6/9/04 11:45	21.87	0.634	-	-	0.13	0.091	-	-	-	-	-	-	-
6/9/04 12:00	21.99	0.634	-	-	0.13	0.090	-	-	-	-	-	-	-
6/9/04 12:15	22.11	0.633	-	-	0.13	0.089	-	-	-	-	-	-	-
6/9/04 12:30	22.24	0.633	-	-	0.13	0.088	-	-	-	-	-	-	-
6/9/04 12:45	22.39	0.633	-	-	0.12	0.088	-	-	-	-	-	-	-
6/9/04 13:00	22.53	0.632	-	-	0.12	0.087	-	-	-	-	-	-	-

School Branch Wet Season Events A and B

	Station SB 1									Station SB 3			
DateTime	Temp (ºC)	SpCond (mS/cm)	DO (mg/L)	DO Test (mV)	Pressure (psig)	Depth (m)	pH	pH Test (mV)	ORP (mV)	Temp (ºC)	SpCond (mS/cm)	Pressure (psig)	Depth (m)
6/11/04 13:00	20.01	0.466	-	-	0.44	0.311	-	-	-	-	-	-	-
6/11/04 13:15	20.02	0.467	-	-	0.44	0.313	-	-	-	-	-	-	-
6/11/04 13:30	19.99	0.470	-	-	0.45	0.315	-	-	-	-	-	-	-
6/11/04 13:45	19.94	0.474	-	-	0.45	0.317	-	-	-	-	-	-	-
6/11/04 14:00	19.91	0.477	-	-	0.45	0.318	-	-	-	-	-	-	-
6/11/04 14:15	19.88	0.481	-	-	0.45	0.318	-	-	-	-	-	-	-
6/11/04 14:30	19.85	0.484	-	-	0.45	0.318	-	-	-	-	-	-	-
6/11/04 14:45	19.82	0.487	-	-	0.45	0.318	-	-	-	-	-	-	-
6/11/04 15:00	19.82	0.490	-	-	0.45	0.317	-	-	-	-	-	-	-
6/11/04 15:15	19.85	0.493	-	-	0.45	0.317	-	-	-	-	-	-	-
6/11/04 15:30	19.93	0.494	-	-	0.45	0.317	-	-	-	-	-	-	-
6/11/04 15:45	20.00	0.496	-	-	0.45	0.316	-	-	-	-	-	-	-
6/11/04 16:00	20.04	0.498	-	-	0.44	0.314	-	-	-	-	-	-	-
6/11/04 16:15	20.09	0.499	-	-	0.44	0.312	-	-	-	-	-	-	-
6/11/04 16:30	20.13	0.501	-	-	0.44	0.310	-	-	-	-	-	-	-
6/11/04 16:45	20.17	0.503	-	-	0.44	0.309	-	-	-	-	-	-	-
6/11/04 17:00	20.18	0.504	-	-	0.43	0.307	-	-	-	-	-	-	-
6/11/04 17:15	20.21	0.505	-	-	0.44	0.308	-	-	-	-	-	-	-
6/11/04 17:30	20.32	0.502	-	-	0.43	0.303	-	-	-	-	-	-	-
6/11/04 17:45	20.40	0.502	-	-	0.43	0.301	-	-	-	-	-	-	-
6/11/04 18:00	20.36	0.505	-	-	0.42	0.299	-	-	-	-	-	-	-
6/11/04 18:15	20.36	0.505	-	-	0.42	0.297	-	-	-	-	-	-	-
6/11/04 18:30	20.35	0.506	-	-	0.42	0.296	-	-	-	-	-	-	-
6/11/04 18:45	20.34	0.507	-	-	0.42	0.294	-	-	-	-	-	-	-
6/11/04 19:00	20.32	0.508	-	-	0.42	0.293	-	-	-	-	-	-	-

Fishback Creek Wet Season Event A

	Station FC 1									Station FC 4			
DateTime	Temp (ºC)	SpCond (mS/cm)	DO (mg/L)	DO Test (mV)	Pressure (psig)	Depth (m)	pH	pH Test (mV)	ORP (mV)	Temp (ºC)	SpCond (mS/cm)	Pressure (psig)	Depth (m)
6/16/04 10:00	20.83	0.408	8.88	39	0.91	0.645	7.91	-61.3	221	-	-	-	-
6/16/04 10:15	20.82	0.408	8.89	38	0.92	0.649	7.9	-61.1	222	-	-	-	-
6/16/04 10:30	20.82	0.405	8.88	39	0.92	0.65	7.9	-61.2	223	-	-	-	-
6/16/04 10:45	20.81	0.407	8.88	38	0.92	0.653	7.9	-61.1	225	-	-	-	-
6/16/04 11:00	20.8	0.406	8.89	39	0.93	0.655	7.91	-61.3	226	-	-	-	-
6/16/04 11:15	20.78	0.402	8.9	39	0.95	0.668	7.91	-61.6	226	-	-	-	-
6/16/04 11:30	20.74	0.395	8.89	39	0.98	0.692	7.91	-61.3	227	-	-	-	-
6/16/04 11:45	20.73	0.385	8.9	39	1.03	0.726	7.9	-60.7	228	-	-	-	-
6/16/04 12:00	20.75	0.378	8.91	38	1.07	0.757	7.89	-60.2	229	-	-	-	-
6/16/04 12:15	20.76	0.358	8.94	38	1.1	0.774	7.87	-59	231	-	-	-	-
6/16/04 12:30	20.83	0.361	8.97	39	1.13	0.799	7.85	-58.3	232	-	-	-	-
6/16/04 12:45	20.9	0.357	8.99	39	1.16	0.817	7.84	-57.6	233	-	-	-	-
6/16/04 13:00	20.97	0.358	8.97	38	1.17	0.823	7.84	-57.2	235	-	-	-	-
6/16/04 13:15	21.05	0.365	8.97	38	1.18	0.833	7.84	-57.4	237	-	-	-	-
6/16/04 13:30	21.13	0.371	8.93	39	1.18	0.834	7.84	-57.4	238	-	-	-	-
6/16/04 13:45	21.2	0.375	8.9	38	1.18	0.833	7.84	-57.4	240	-	-	-	-
6/16/04 14:00	21.24	0.376	8.86	39	1.18	0.83	7.84	-57.6	242	-	-	-	-

Fishback Creek Wet Season Event B

	Station FC 1									Station FC 4			
DateTime	Temp (ºC)	SpCond (mS/cm)	DO (mg/L)	DO Test (mV)	Pressure (psig)	Depth (m)	pH	pH Test (mV)	ORP (mV)	Temp (ºC)	SpCond (mS/cm)	Pressure (psig)	Depth (m)
6/17/04 9:00	21.33	0.457	8.78	38	0.88	0.619	7.9	-60.9	272	-	-	-	-
6/17/04 9:15	21.34	0.458	8.79	38	0.87	0.617	7.9	-61.1	271	-	-	-	-
6/17/04 9:30	21.35	0.459	8.8	38	0.87	0.614	7.91	-61.5	272	-	-	-	-
6/17/04 9:45	21.36	0.461	8.81	37	0.87	0.612	7.91	-61.6	272	-	-	-	-
6/17/04 10:00	21.38	0.464	8.81	38	0.86	0.609	7.91	-61.7	272	-	-	-	-
6/17/04 10:15	21.4	0.464	8.82	37	0.86	0.607	7.92	-62.1	272	-	-	-	-
6/17/04 10:30	21.41	0.465	8.84	38	0.86	0.603	7.92	-62.2	273	-	-	-	-
6/17/04 10:45	21.44	0.468	8.84	38	0.85	0.602	7.92	-62.4	273	-	-	-	-
6/17/04 11:00	21.48	0.47	8.85	38	0.85	0.6	7.93	-62.6	273	-	-	-	-
6/17/04 11:15	21.5	0.471	8.87	38	0.85	0.598	7.93	-62.9	273	-	-	-	-
6/17/04 11:30	21.56	0.473	8.88	37	0.84	0.595	7.94	-63.2	273	-	-	-	-
6/17/04 11:45	21.6	0.473	8.87	38	0.84	0.593	7.94	-63.4	273	-	-	-	-
6/17/04 12:00	21.65	0.476	8.89	38	0.84	0.591	7.94	-63.7	274	-	-	-	-
6/17/04 12:15	21.71	0.478	8.9	37	0.84	0.59	7.95	-64	274	-	-	-	-
6/17/04 12:30	21.79	0.479	8.91	38	0.83	0.588	7.95	-64.2	273	-	-	-	-
6/17/04 12:45	21.86	0.481	8.91	38	0.83	0.586	7.95	-64.3	272	-	-	-	-
6/17/04 13:00	21.95	0.481	8.93	38	0.83	0.584	7.96	-64.7	273	-	-	-	-

Fishback Creek Dry Season Base A

	Station FC 1									Station FC 4			
DateTime	Temp (ºC)	SpCond (mS/cm)	DO (mg/L)	DO Test (mV)	Pressure (psig)	Depth (m)	pH	pH Test (mV)	ORP (mV)	Temp (ºC)	SpCond (mS/cm)	Pressure (psig)	Depth (m)
9/9/04 9:00	-	-	-	-	-	-	-	-	-	18.2	102.965	0.12	0.081
9/9/04 9:15	-	-	-	-	-	-	-	-	-	18.19	103.009	0.12	0.081
9/9/04 9:30	-	-	-	-	-	-	-	-	-	18.17	103.099	0.12	0.081
9/9/04 9:45	-	-	-	-	-	-	-	-	-	18.19	103.117	0.12	0.081
9/9/04 10:00	-	-	-	-	-	-	-	-	-	18.21	103.193	0.12	0.081
9/9/04 10:15	-	-	-	-	-	-	-	-	-	18.23	103.588	0.12	0.081
9/9/04 10:30	-	-	-	-	-	-	-	-	-	18.26	103.927	0.12	0.081
9/9/04 10:45	-	-	-	-	-	-	-	-	-	18.3	104.065	0.12	0.08
9/9/04 11:00	-	-	-	-	-	-	-	-	-	18.33	104.09	0.12	0.081
9/9/04 11:15	-	-	-	-	-	-	-	-	-	18.37	104.033	0.12	0.08
9/9/04 11:30	-	-	-	-	-	-	-	-	-	18.45	103.82	0.12	0.08
9/9/04 11:45	-	-	-	-	-	-	-	-	-	18.53	103.645	0.12	0.08
9/9/04 12:00	-	-	-	-	-	-	-	-	-	18.65	103.563	0.12	0.08
9/9/04 12:15	-	-	-	-	-	-	-	-	-	18.74	103.655	0.12	0.08
9/9/04 12:30	-	-	-	-	-	-	-	-	-	19	103.539	0.12	0.08
9/9/04 12:45	-	-	-	-	-	-	-	-	-	19.24	103.735	0.12	0.08
9/9/04 13:00	-	-	-	-	-	-	-	-	-	19.51	103.968	0.12	0.08
9/9/04 13:15	-	-	-	-	-	-	-	-	-	19.65	104.134	0.12	0.081
9/9/04 13:30	-	-	-	-	-	-	-	-	-	19.71	104.395	0.12	0.08
9/9/04 13:45	-	-	-	-	-	-	-	-	-	19.54	104.583	0.12	0.08
9/9/04 14:00	-	-	-	-	-	-	-	-	-	19.39	104.585	0.12	0.079

School Branch Dry Season Base A

	Station SB 1									Station SB 3			
DateTime	Temp (ºC)	SpCond (mS/cm)	DO (mg/L)	DO Test (mV)	Pressure (psig)	Depth (m)	pH	pH Test (mV)	ORP (mV)	Temp (ºC)	SpCond (mS/cm)	Pressure (psig)	Depth (m)
9/15/04 10:00	19.27	0.659	6.7	36	0.35	0.246	8.08	-75.3	298	19.03	0.009	-	-0.377
9/15/04 10:15	19.29	0.659	6.73	37	0.35	0.246	8.08	-75.3	298	19.16	0.009	-	-0.383
9/15/04 10:30	19.35	0.659	6.78	37	0.35	0.246	8.08	-75.3	298	19.29	0.009	-	-0.385
9/15/04 10:45	19.43	0.658	6.81	36	0.35	0.245	8.08	-75.3	298	19.42	0.009	-	-0.394
9/15/04 11:00	19.53	0.658	6.87	36	0.35	0.245	8.08	-75.4	298	19.55	0.008	-	-0.4
9/15/04 11:15	19.6	0.657	6.91	36	0.35	0.245	8.08	-75.6	298	19.67	0.008	-	-0.406
9/15/04 11:30	19.67	0.656	6.92	37	0.35	0.244	8.08	-75.4	298	19.8	0.008	-	-0.416
9/15/04 11:45	19.76	0.656	6.98	37	0.35	0.244	8.08	-75.5	297	19.86	0.008	-	-0.424
9/15/04 12:00	19.86	0.656	6.98	37	0.35	0.244	8.08	-75.6	296	20.03	0.007	-	-0.431

School Branch Dry Season Base B

	Station SB 1									Station SB 3			
DateTime	Temp (ºC)	SpCond (mS/cm)	DO (mg/L)	DO Test (mV)	Pressure (psig)	Depth (m)	pH	pH Test (mV)	ORP (mV)	Temp (ºC)	SpCond (mS/cm)	Pressure (psig)	Depth (m)
10/13/04 10:00	12.39	0.69	8.63	38	0.39	0.278	8.13	-76.8	286	12.86	0.005	-	-0.211
10/13/04 10:15	12.4	0.689	8.65	38	0.39	0.278	8.13	-76.8	286	12.89	0.006	-	-0.21
10/13/04 10:30	12.42	0.688	8.62	38	0.39	0.277	8.13	-76.8	286	12.93	0.006	-	-0.209
10/13/04 10:45	12.43	0.687	8.61	39	0.39	0.277	8.13	-76.8	286	12.96	0.006	-	-0.211
10/13/04 11:00	12.45	0.684	8.61	38	0.39	0.277	8.13	-76.6	286	13	0.006	-	-0.209
10/13/04 11:15	12.46	0.681	8.59	38	0.39	0.276	8.12	-76.4	286	13.04	0.006	-	-0.213
10/13/04 11:30	12.48	0.677	8.57	38	0.39	0.276	8.12	-76.3	286	13.06	0.006	-	-0.216
10/13/04 11:45	12.5	0.673	8.54	37	0.39	0.276	8.12	-76	286	13.09	0.006	-	-0.217
10/13/04 12:00	12.52	0.668	8.51	38	0.39	0.275	8.11	-75.8	286	13.14	0.006	-	-0.218

Fishback Creek Dry Season Event A

	Station FC 1									Station FC 4			
DateTime	Temp (ºC)	SpCond (mS/cm)	DO (mg/L)	DO Test (mV)	Pressure (psig)	Depth (m)	pH	pH Test (mV)	ORP (mV)	Temp (ºC)	SpCond (mS/cm)	Pressure (psig)	Depth (m)
10/15/04 10:00	11.53	9320.191	-	-	-	-	-	-	-	13.13	64.229	0.55	0.374
10/15/04 10:15	11.51	9311.698	-	-	-	-	-	-	-	13.13	64.275	0.55	0.374
10/15/04 10:30	11.51	9300.367	-	-	-	-	-	-	-	13.12	64.304	0.55	0.373
10/15/04 10:45	11.51	9304.881	-	-	-	-	-	-	-	13.11	64.287	0.55	0.373
10/15/04 11:00	11.49	9297.238	-	-	-	-	-	-	-	13.1	64.291	0.55	0.372
10/15/04 11:15	11.47	9302.449	-	-	-	-	-	-	-	13.09	64.279	0.55	0.372
10/15/04 11:30	11.47	9299.348	-	-	-	-	-	-	-	13.09	64.238	0.55	0.372
10/15/04 11:45	11.45	9295.825	-	-	-	-	-	-	-	13.06	64.158	0.54	0.371
10/15/04 12:00	11.44	9289.045	-	-	-	-	-	-	-	13.07	64.116	0.55	0.372
10/15/04 12:15	11.42	9276.876	-	-	-	-	-	-	-	13.06	64.088	0.54	0.37
10/15/04 12:30	11.42	9258.868	-	-	-	-	-	-	-	13.07	64.069	0.55	0.372
10/15/04 12:45	11.43	9225.643	-	-	-	-	-	-	-	13.07	64.133	0.55	0.372
10/15/04 13:00	11.42	9207.66	-	-	-	-	-	-	-	13.08	64.264	0.55	0.372
10/15/04 13:15	11.43	9160.287	-	-	-	-	-	-	-	13.07	64.516	0.55	0.373
10/15/04 13:30	11.43	9168.629	-	-	-	-	-	-	-	13.07	64.956	0.55	0.373
10/15/04 13:45	11.44	9137.41	-	-	-	-	-	-	-	13.07	65.421	0.55	0.374
10/15/04 14:00	11.45	9099.689	-	-	-	-	-	-	-	13.07	65.621	0.55	0.374

School Branch Dry Season Event A

	Station SB 1									Station SB 3			
DateTime	Temp (ºC)	SpCond (mS/cm)	DO (mg/L)	DO Test (mV)	Pressure (psig)	Depth (m)	pH	pH Test (mV)	ORP (mV)	Temp (ºC)	SpCond (mS/cm)	Pressure (psig)	Depth (m)
11/2/04 15:00	-	-	-	-	-	-	-	-	-	14.72	0.595	-	-0.047
11/2/04 15:15	-	-	-	-	-	-	-	-	-	14.7	0.598	-	-0.016
11/2/04 15:30	-	-	-	-	-	-	-	-	-	14.67	0.599	-	-0.018
11/2/04 15:45	-	-	-	-	-	-	-	-	-	14.64	0.601	-	-0.021
11/2/04 16:00	-	-	-	-	-	-	-	-	-	14.61	0.603	-	-0.019
11/2/04 16:15	-	-	-	-	-	-	-	-	-	14.58	0.604	-	-0.005
11/2/04 16:30	-	-	-	-	-	-	-	-	-	14.55	0.606	-	-0.001
11/2/04 16:45	-	-	-	-	-	-	-	-	-	14.52	0.608	-	-0.001
11/2/04 17:00	-	-	-	-	-	-	-	-	-	14.49	0.612	-	0.008
11/2/04 17:15	-	-	-	-	-	-	-	-	-	14.45	0.615	-	0.003
11/2/04 17:30	-	-	-	-	-	-	-	-	-	14.42	0.618	-	0.007
11/2/04 17:45	-	-	-	-	-	-	-	-	-	14.38	0.62	-	0.027
11/2/04 18:00	-	-	-	-	-	-	-	-	-	14.35	0.623	-	0.045

Fishback Creek Dry Season Event B

	Station FC 1									Station FC 4			
DateTime	Temp (ºC)	SpCond (mS/cm)	DO (mg/L)	DO Test (mV)	Pressure (psig)	Depth (m)	pH	pH Test (mV)	ORP (mV)	Temp (ºC)	SpCond (mS/cm)	Pressure (psig)	Depth (m)
11/2/04 9:00	14.63	7262.387	-	-	-	-	-	-	-	14.75	143.155	0.57	0.368
11/2/04 9:15	14.63	7264.253	-	-	-	-	-	-	-	14.76	142.889	0.57	0.37
11/2/04 9:30	14.62	7252.42	-	-	-	-	-	-	-	14.77	142.769	0.58	0.378
11/2/04 9:45	14.62	7236.992	-	-	-	-	-	-	-	14.79	142.643	0.59	0.384
11/2/04 10:00	14.62	7230.601	-	-	-	-	-	-	-	14.8	142.378	0.59	0.385
11/2/04 10:15	14.62	7221.564	-	-	-	-	-	-	-	14.81	142.452	0.59	0.385
11/2/04 10:30	14.61	7220.476	-	-	-	-	-	-	-	14.83	141.263	0.59	0.384
11/2/04 10:45	14.61	7226.573	-	-	-	-	-	-	-	14.84	140.713	0.59	0.382
11/2/04 11:00	14.61	7237.8	-	-	-	-	-	-	-	14.86	138.959	0.59	0.381
11/2/04 11:15	14.61	7256.964	-	-	-	-	-	-	-	14.88	136.648	0.58	0.38
11/2/04 11:30	14.62	7298.114	-	-	-	-	-	-	-	14.9	134.117	0.58	0.378
11/2/04 11:45	14.62	7390.702	-	-	-	-	-	-	-	14.91	130.704	0.58	0.378
11/2/04 12:00	14.61	7560.749	-	-	-	-	-	-	-	14.92	127.627	0.58	0.377
11/2/04 12:15	14.59	7691.534	-	-	-	-	-	-	-	14.92	123.683	0.57	0.377
11/2/04 12:30	14.57	7828.956	-	-	-	-	-	-	-	14.92	120.443	0.57	0.378
11/2/04 12:45	14.55	7882.689	-	-	-	-	-	-	-	14.92	118.03	0.58	0.379
11/2/04 13:00	14.53	7923.401	-	-	-	-	-	-	-	14.91	116.073	0.58	0.38
11/2/04 13:15	14.5	7933.273	-	-	-	-	-	-	-	14.91	114.767	0.58	0.381
11/2/04 13:30	14.48	7906.797	-	-	-	-	-	-	-	14.9	113.623	0.58	0.382
11/2/04 13:45	14.47	7872.292	-	-	-	-	-	-	-	14.89	112.57	0.58	0.383
11/2/04 14:00	14.46	7831.333	-	-	-	-	-	-	-	14.88	111.764	0.58	0.383
11/2/04 14:15	14.45	7794.835	-	-	-	-	-	-	-	14.88	111.135	0.58	0.383
11/2/04 14:30	14.44	7791.66	-	-	-	-	-	-	-	14.87	110.646	0.58	0.384
11/2/04 14:45	14.43	7781.363	-	-	-	-	-	-	-	14.86	110.449	0.58	0.384
11/2/04 15:00	14.42	7774.752	-	-	-	-	-	-	-	14.84	110.085	0.58	0.384

Fishback Creek Wet Season Base B

	Station FC 1									Station FC 4			
DateTime	Temp (ºC)	SpCond (mS/cm)	DO (mg/L)	DO Test (mV)	Pressure (psig)	Depth (m)	pH	pH Test (mV)	ORP (mV)	Temp (ºC)	SpCond (mS/cm)	Pressure (psig)	Depth (m)
3/21/2005 9:00	-	-	-	-	-	-	-	-	-	3.45	0.648	0.3	0.214
3/21/2005 9:15	-	-	-	-	-	-	-	-	-	3.49	0.647	0.3	0.214
3/21/2005 9:30	-	-	-	-	-	-	-	-	-	3.56	0.646	0.3	0.214
3/21/2005 9:45	-	-	-	-	-	-	-	-	-	3.64	0.646	0.3	0.214
3/21/2005 10:00	-	-	-	-	-	-	-	-	-	3.73	0.646	0.3	0.214
3/21/2005 10:15	-	-	-	-	-	-	-	-	-	3.83	0.645	0.3	0.214
3/21/2005 10:30	-	-	-	-	-	-	-	-	-	3.98	0.645	0.3	0.215
3/21/2005 10:45	-	-	-	-	-	-	-	-	-	4.15	0.644	0.3	0.213
3/21/2005 11:00	-	-	-	-	-	-	-	-	-	4.33	0.643	0.3	0.214
3/21/2005 11:15	-	-	-	-	-	-	-	-	-	4.51	0.643	0.3	0.215
3/21/2005 11:30	-	-	-	-	-	-	-	-	-	4.72	0.643	0.3	0.214
3/21/2005 11:45	-	-	-	-	-	-	-	-	-	4.96	0.642	0.31	0.215
3/21/2005 12:00	-	-	-	-	-	-	-	-	-	5.18	0.642	0.31	0.215
3/21/2005 12:15	-	-	-	-	-	-	-	-	-	5.42	0.642	0.3	0.214
3/21/2005 12:30	-	-	-	-	-	-	-	-	-	5.66	0.641	0.31	0.215
3/21/2005 12:45	-	-	-	-	-	-	-	-	-	5.89	0.64	0.3	0.214
3/21/2005 13:00	-	-	-	-	-	-	-	-	-	6.16	0.64	0.31	0.215
3/21/2005 13:15	-	-	-	-	-	-	-	-	-	6.41	0.639	0.3	0.214
3/21/2005 13:30	-	-	-	-	-	-	-	-	-	6.64	0.638	0.31	0.215
3/21/2005 13:45	-	-	-	-	-	-	-	-	-	6.86	0.638	0.3	0.214
3/21/2005 14:00	-	-	-	-	-	-	-	-	-	7.06	0.637	0.31	0.215
3/21/2005 14:15	-	-	-	-	-	-	-	-	-	7.27	0.636	0.3	0.214
3/21/2005 14:30	-	-	-	-	-	-	-	-	-	7.45	0.635	0.31	0.215
3/21/2005 14:45	-	-	-	-	-	-	-	-	-	7.63	0.634	0.31	0.217
3/21/2005 15:00	-	-	-	-	-	-	-	-	-	7.81	0.632	0.31	0.215

School Branch Wet Season Base B

	Station SB 1									Station SB 3			
DateTime	Temp (ºC)	SpCond (mS/cm)	DO (mg/L)	DO Test (mV)	Pressure (psig)	Depth (m)	pH	pH Test (mV)	ORP (mV)	Temp (ºC)	SpCond (mS/cm)	Pressure (psig)	Depth (m)
3/21/2005 15:00	6.68	0.538	10.68	25	0.34	0.237	8.3	-103.2	293	7.78	0.443	0.23	0.16
3/21/2005 15:15	6.89	0.538	10.7	25	0.34	0.237	8.3	-103.3	292	7.91	0.439	0.23	0.16
3/21/2005 15:30	7.09	0.538	10.72	25	0.34	0.237	8.3	-103.5	291	7.97	0.436	0.23	0.161
3/21/2005 15:45	7.25	0.538	10.73	25	0.34	0.237	8.31	-103.6	291	8.08	0.432	0.23	0.16
3/21/2005 16:00	7.43	0.538	10.73	25	0.34	0.237	8.31	-103.9	290	8.18	0.429	0.23	0.16
3/21/2005 16:15	7.6	0.538	10.73	25	0.34	0.237	8.31	-104.1	290	8.25	0.428	0.23	0.159
3/21/2005 16:30	7.74	0.538	10.72	25	0.34	0.237	8.31	-104.1	290	8.34	0.427	0.22	0.158
3/21/2005 16:45	7.86	0.538	10.71	25	0.34	0.237	8.31	-104.3	289	8.4	0.426	0.22	0.158
3/21/2005 17:00	7.91	0.538	10.7	25	0.34	0.238	8.31	-104.4	289	8.44	0.426	0.22	0.157
3/21/2005 17:15	7.97	0.538	10.66	25	0.34	0.237	8.32	-104.4	289	8.45	0.426	0.22	0.157
3/21/2005 17:30	7.99	0.538	10.65	25	0.34	0.237	8.32	-104.4	288	8.49	0.426	0.22	0.156
3/21/2005 17:45	8.02	0.539	10.6	25	0.34	0.237	8.32	-104.6	288	8.5	0.427	0.22	0.155
3/21/2005 18:00	7.99	0.539	10.57	25	0.34	0.238	8.32	-104.5	288	8.49	0.428	0.22	0.155

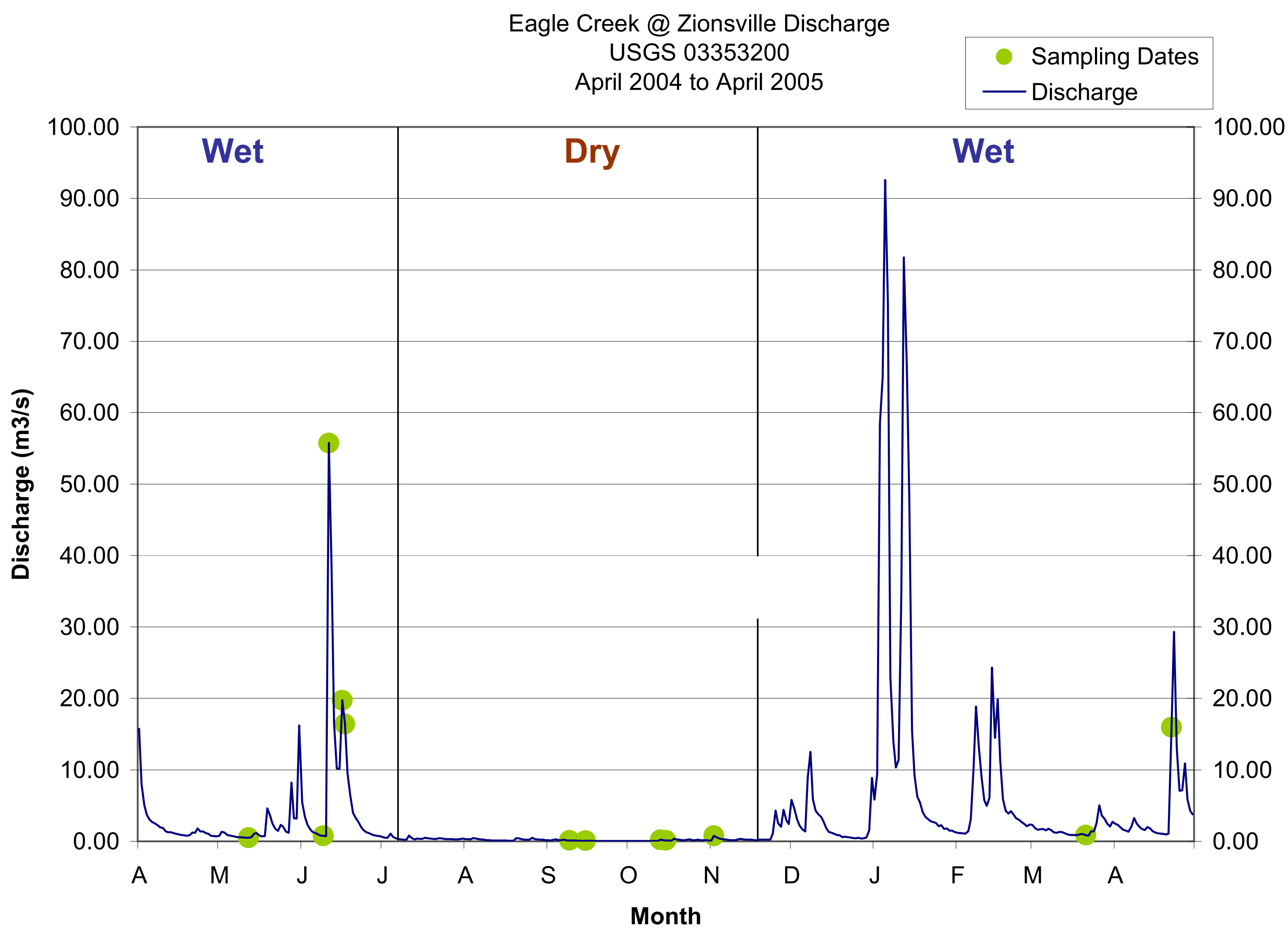
Fishback Creek Wet Season Event C

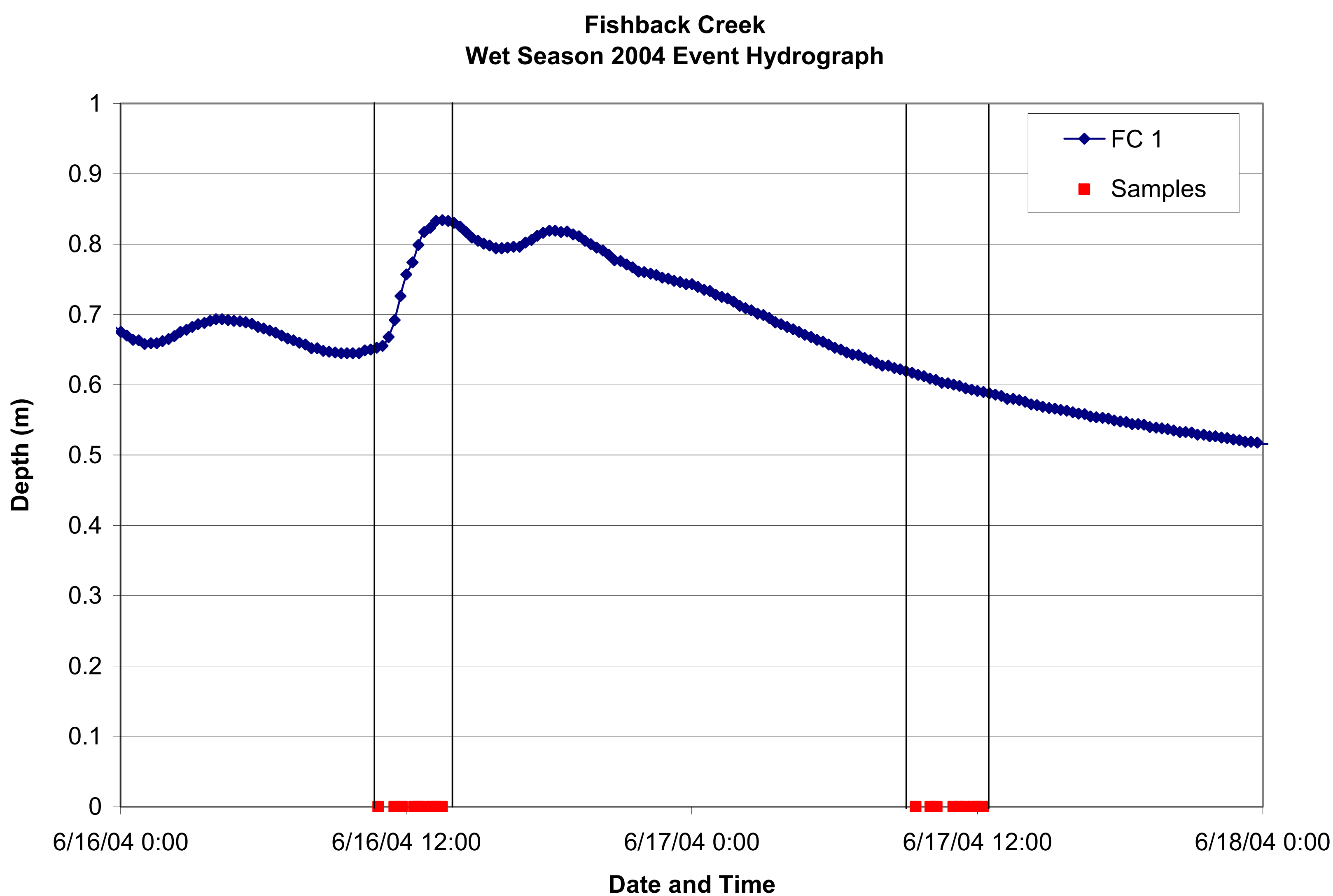
	Station FC 1									Station FC 4			
DateTime	Temp (ºC)	SpCond (mS/cm)	DO (mg/L)	DO Test (mV)	Pressure (psig)	Depth (m)	pH	pH Test (mV)	ORP (mV)	Temp (ºC)	SpCond (mS/cm)	Pressure (psig)	Depth (m)
4/22/2005 9:00	-	-	-	-	-	-	-	-	-	13.54	0.57	0.72	0.508
4/22/2005 9:15	-	-	-	-	-	-	-	-	-	13.61	0.565	0.75	0.525
4/22/2005 9:30	-	-	-	-	-	-	-	-	-	13.71	0.562	0.79	0.554
4/22/2005 9:45	-	-	-	-	-	-	-	-	-	13.74	0.556	0.82	0.58
4/22/2005 10:00	-	-	-	-	-	-	-	-	-	13.66	0.551	0.86	0.604
4/22/2005 10:15	-	-	-	-	-	-	-	-	-	13.51	0.543	0.88	0.622
4/22/2005 10:30	-	-	-	-	-	-	-	-	-	13.35	0.533	0.91	0.639
4/22/2005 10:45	-	-	-	-	-	-	-	-	-	13.22	0.524	0.93	0.655
4/22/2005 11:00	-	-	-	-	-	-	-	-	-	13.14	0.511	0.95	0.667
4/22/2005 11:15	-	-	-	-	-	-	-	-	-	13.06	0.492	0.96	0.68
4/22/2005 11:30	-	-	-	-	-	-	-	-	-	13	0.473	0.98	0.693
4/22/2005 11:45	-	-	-	-	-	-	-	-	-	12.94	0.468	0.99	0.699
4/22/2005 12:00	-	-	-	-	-	-	-	-	-	12.9	0.471	1	0.703
4/22/2005 12:15	-	-	-	-	-	-	-	-	-	12.85	0.474	1	0.704
4/22/2005 12:30	-	-	-	-	-	-	-	-	-	12.77	0.473	1.01	0.709
4/22/2005 12:45	-	-	-	-	-	-	-	-	-	12.72	0.467	1.01	0.71
4/22/2005 13:00	-	-	-	-	-	-	-	-	-	12.63	0.459	1.01	0.715
4/22/2005 13:15	-	-	-	-	-	-	-	-	-	12.62	0.449	1.01	0.709
4/22/2005 13:30	-	-	-	-	-	-	-	-	-	12.63	0.441	1.01	0.709
4/22/2005 13:45	-	-	-	-	-	-	-	-	-	12.64	0.438	1.01	0.71
4/22/2005 14:00	-	-	-	-	-	-	-	-	-	12.66	0.437	1	0.705

School Branch Creek Wet Season Event C

	Station SB 1									Station SB 3			
DateTime	Temp (ºC)	SpCond (mS/cm)	DO (mg/L)	DO Test (mV)	Pressure (psig)	Depth (m)	pH	pH Test (mV)	ORP (mV)	Temp (ºC)	SpCond (mS/cm)	Pressure (psig)	Depth (m)
4/22/2005 14:00	-	-	-	-	-	-	-	-	-	13.45	0.438	0.71	0.502
4/22/2005 14:15	-	-	-	-	-	-	-	-	-	13.52	0.439	0.71	0.5
4/22/2005 14:30	-	-	-	-	-	-	-	-	-	13.67	0.439	0.7	0.496
4/22/2005 14:45	-	-	-	-	-	-	-	-	-	13.87	0.439	0.7	0.493
4/22/2005 15:00	-	-	-	-	-	-	-	-	-	14.08	0.44	0.7	0.49
4/22/2005 15:15	-	-	-	-	-	-	-	-	-	14.26	0.44	0.69	0.489
4/22/2005 15:30	-	-	-	-	-	-	-	-	-	14.28	0.44	0.69	0.484
4/22/2005 15:45	-	-	-	-	-	-	-	-	-	14.23	0.44	0.68	0.48
4/22/2005 16:00	-	-	-	-	-	-	-	-	-	14.14	0.44	0.68	0.479

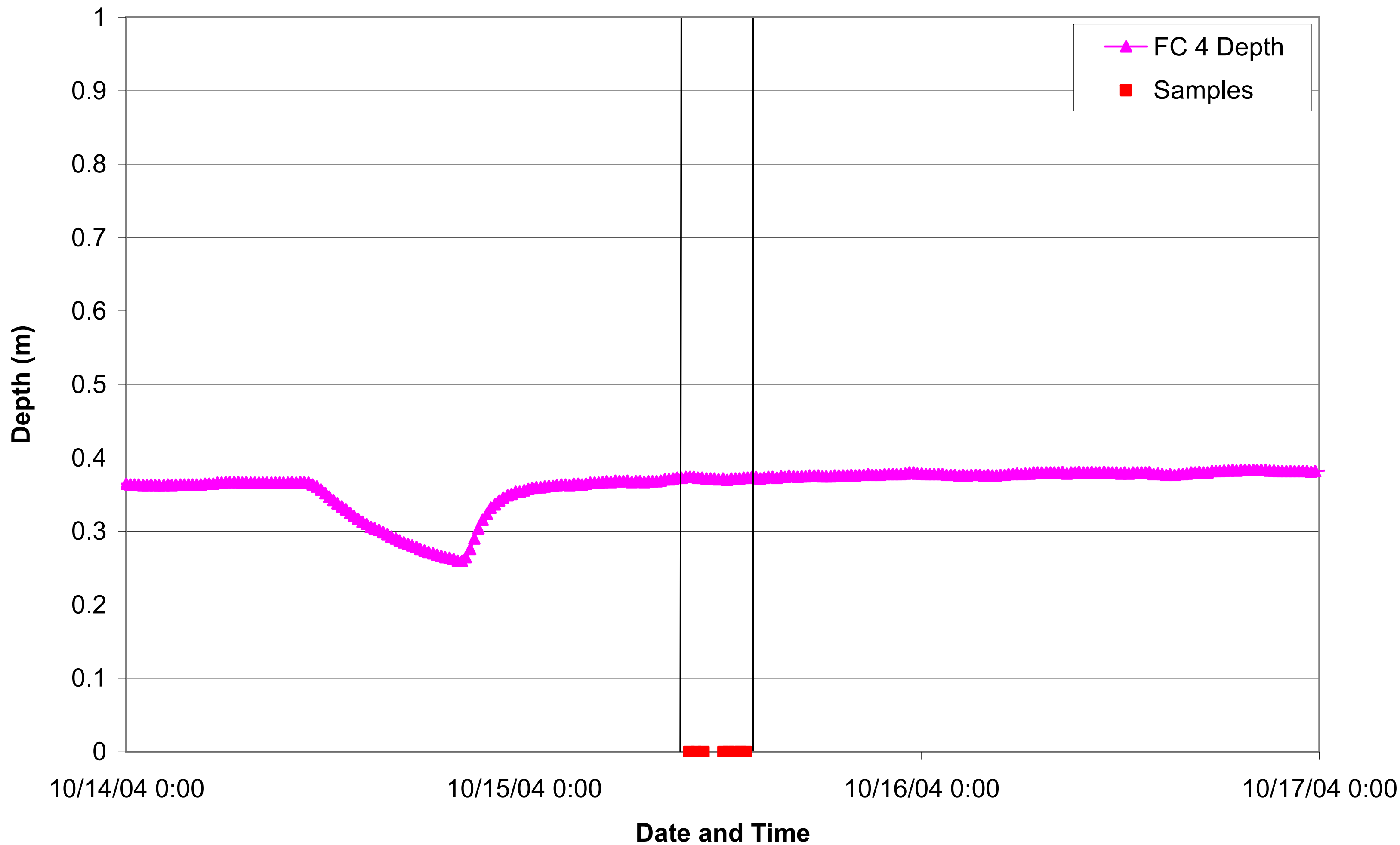
Appendix E. Sampling event hydrographs and weather data.

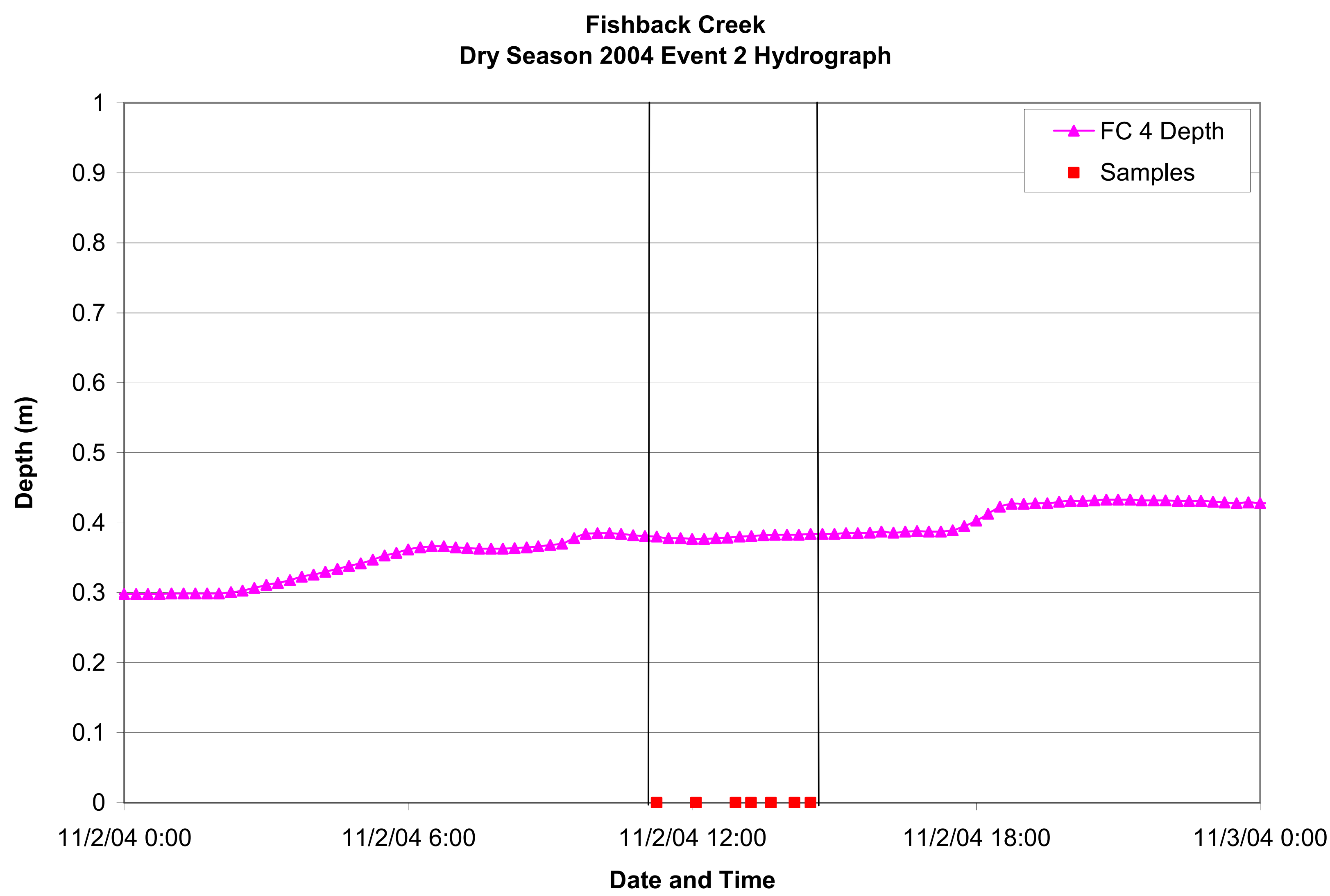

Eagle Creek @ Zionsville Discharge
USGS 03353200
April 2004 to April 2005
Sampling Dates
Discharge
Wet
Dry
Wet
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Discharge (m3/s)
A
M
J
J
A
S
O
N
D
J
F
M
A
Month



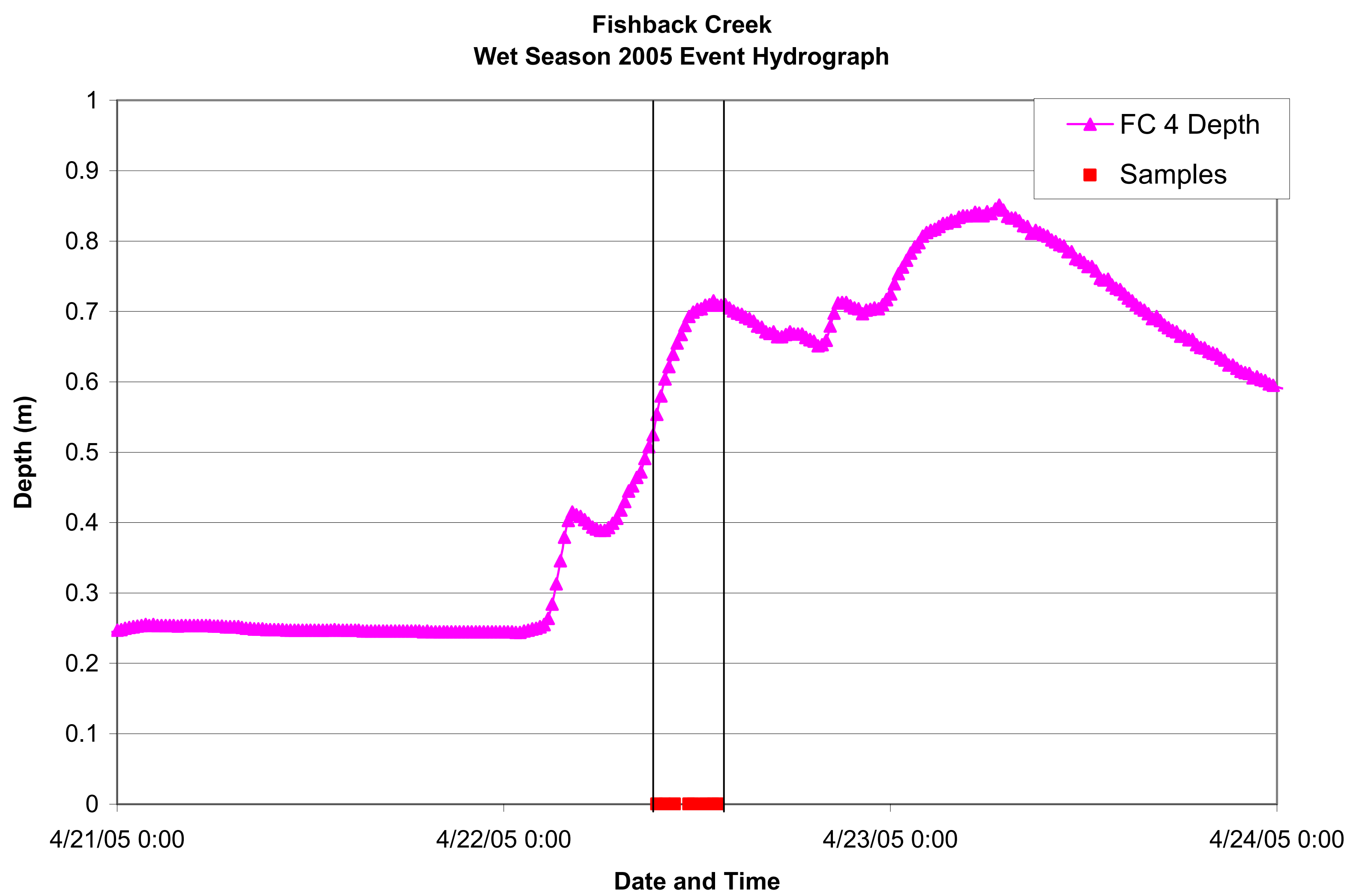
Fishback Creek
Wet Season 2004 Event Hydrograph
Depth (m)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
6/16/04 0:00
6/16/04 12:00
6/17/04 0:00
6/17/04 12:00
6/18/04 0:00
Date and Time
FC 1
Samples

Fishback Creek
Dry Season 2004 Event 1 Hydrograph

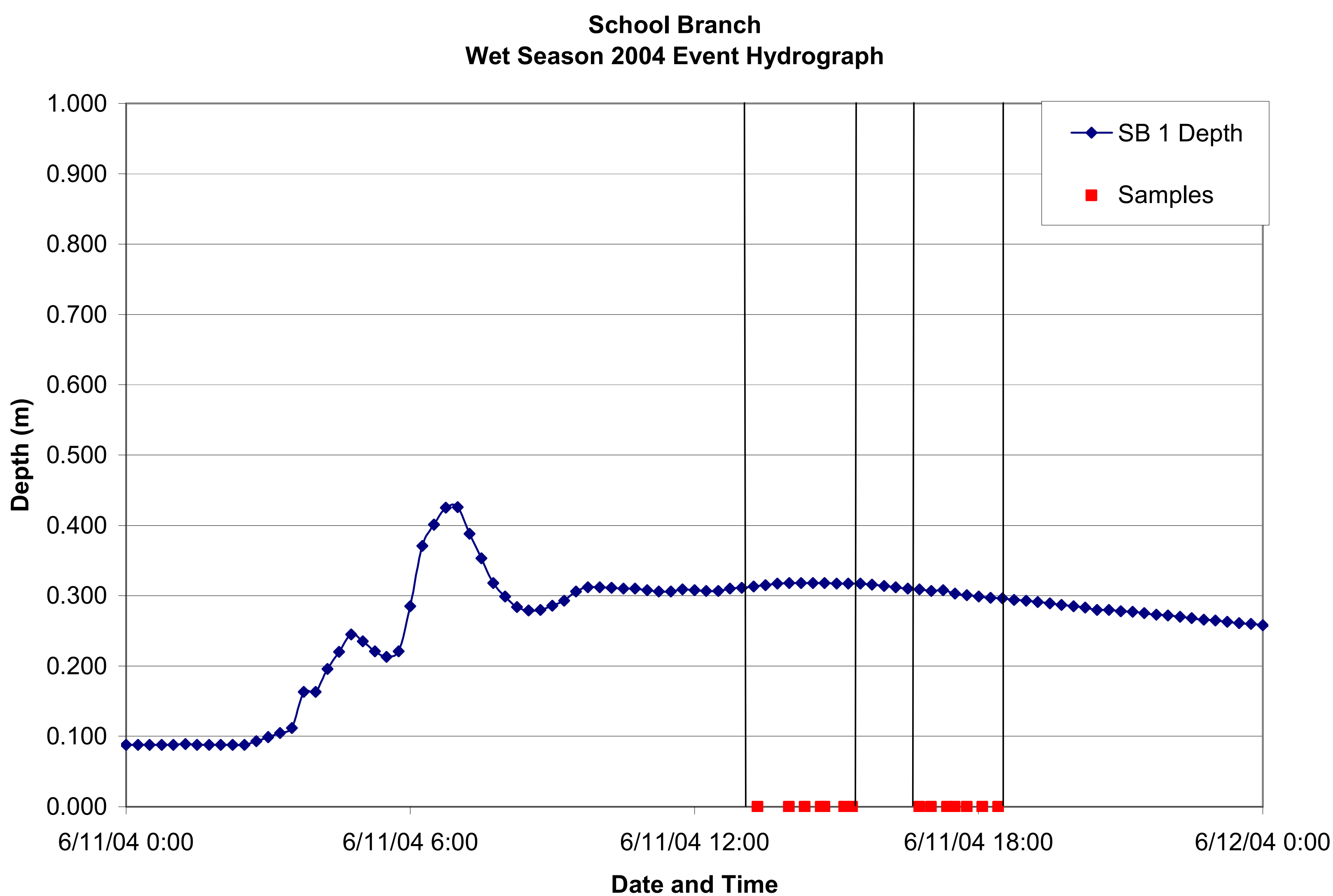


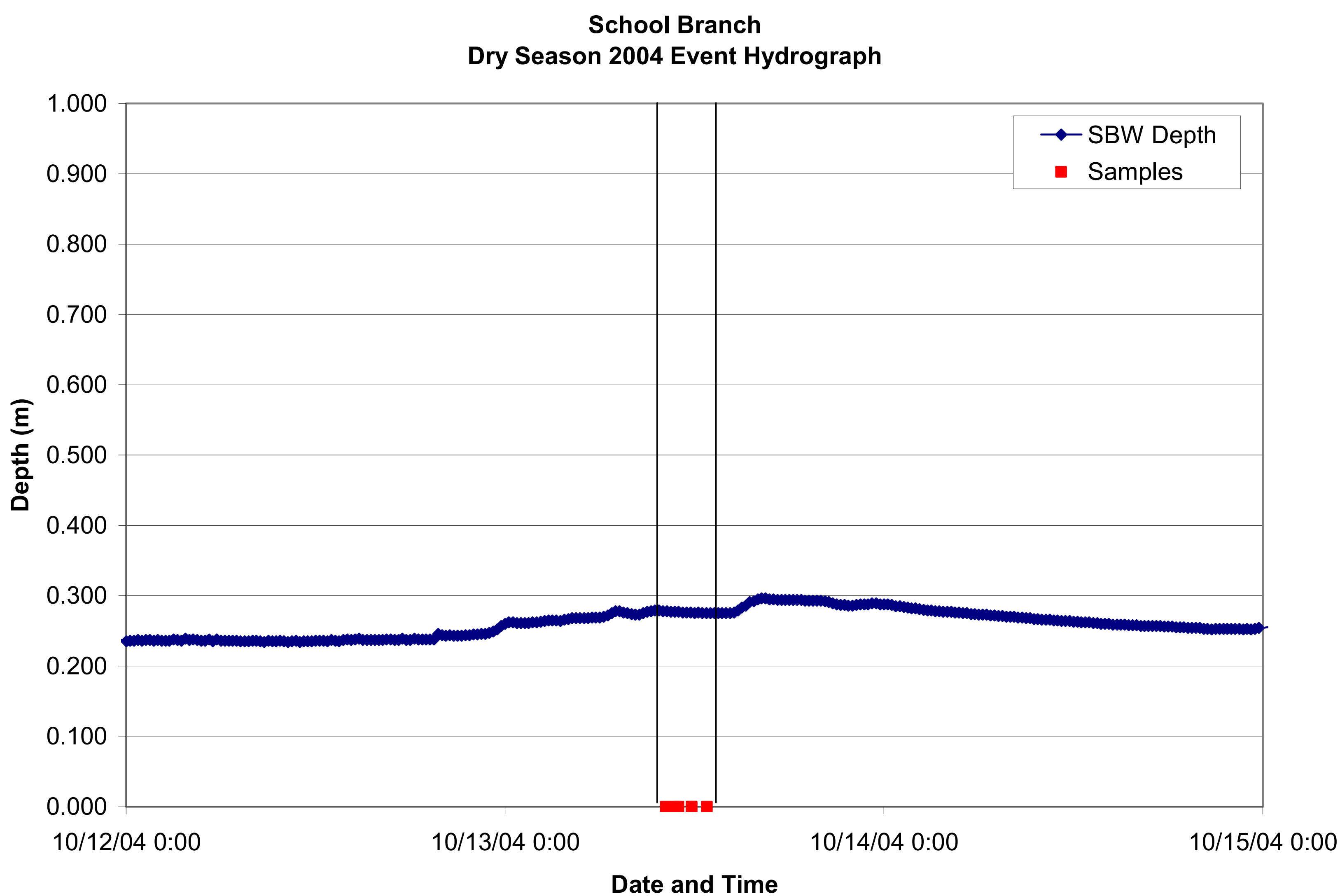


Fishback Creek
Dry Season 2004 Event 2 Hydrograph
Depth (m)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
11/2/04 0:00
11/2/04 6:00
11/2/04 12:00
11/2/04 18:00
11/3/04 0:00
Date and Time
FC 4 Depth
Samples

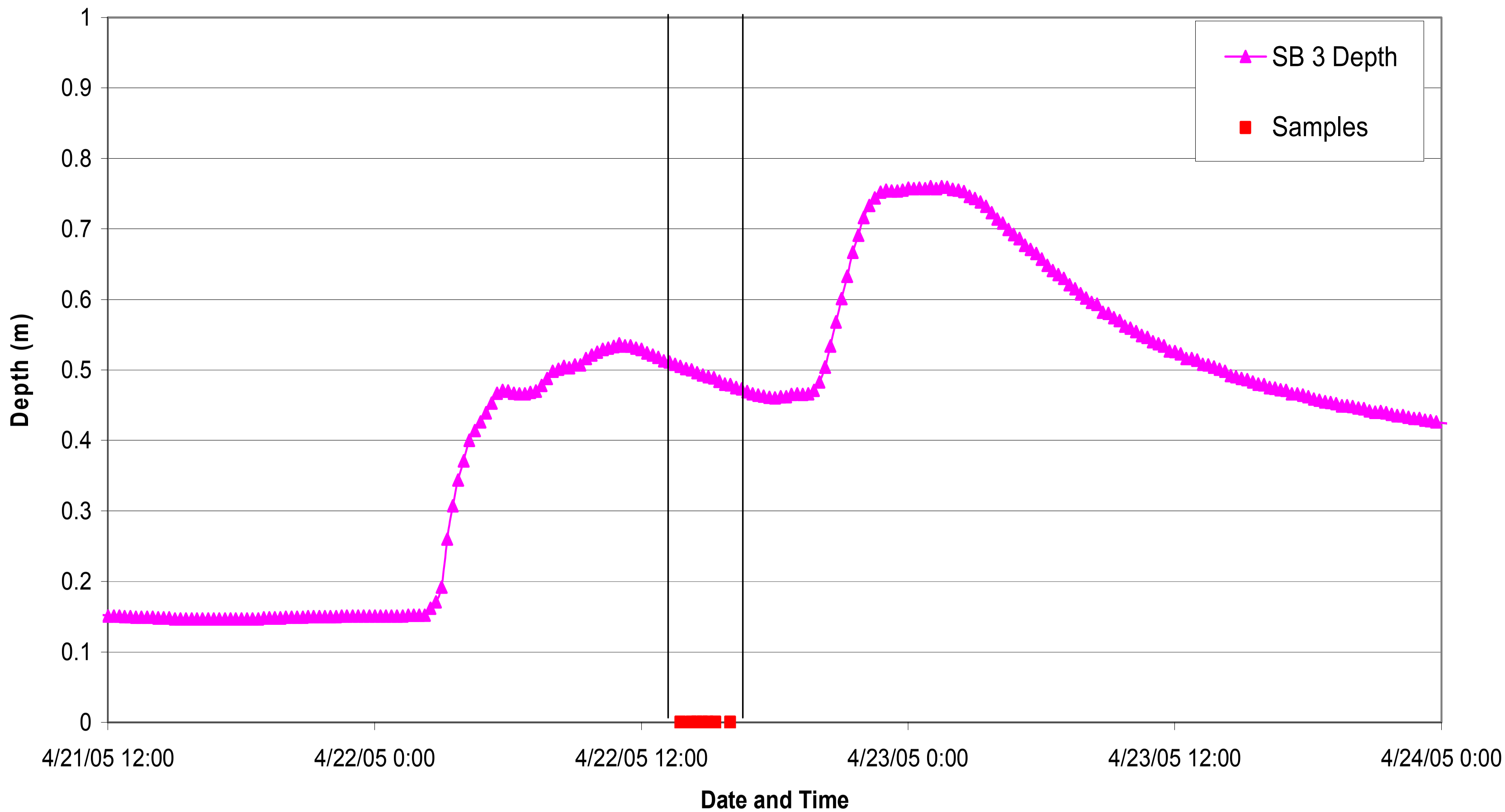


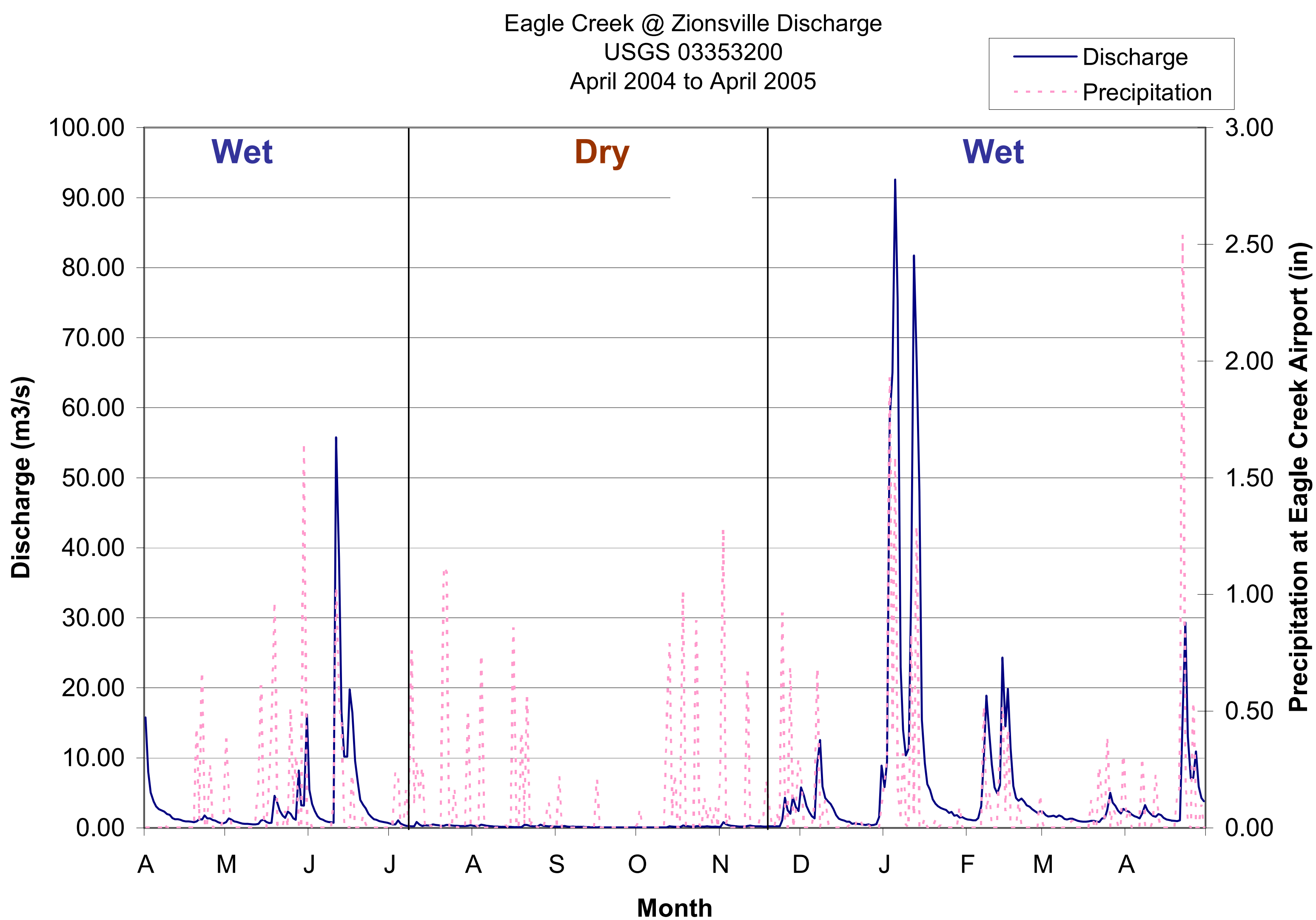
Fishback Creek
Wet Season 2005 Event Hydrograph
Depth (m)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
4/21/05 0:00
4/22/05 0:00
4/23/05 0:00
4/24/05 0:00
Date and Time
FC 4 Depth
Samples


School Branch
Wet Season 2004 Event Hydrograph
Depth (m)
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
6/11/04 0:00
6/11/04 6:00
6/11/04 12:00
6/11/04 18:00
6/12/04 0:00
Date and Time
SB 1 Depth
Samples


School Branch
Dry Season 2004 Event Hydrograph
Depth (m)
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
10/12/04 0:00
10/13/04 0:00
10/14/04 0:00
10/15/04 0:00
Date and Time
SBW Depth
Samples

School Branch
Wet Season 2005 Event Hydrograph





Eagle Creek @ Zionsville Discharge
USGS 03353200
April 2004 to April 2005
Discharge
Precipitation
Wet
Dry
Wet
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Discharge (m3/s)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Precipitation at Eagle Creek Airport (in)
A
M
J
J
A
S
O
N
D
J
F
M
A
Month

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